Does recruiting attentional control in the presence of threat reduce worry?

MacKintosh, Lucy Dorothea

Awarding institution:
King's College London

VOLUME I

Systematic Literature Review

Empirical Research Project

Service Related Project

Lucy Mackintosh

Thesis submitted in partial fulfilment of the degree of Doctorate in Clinical Psychology

Institute of Psychiatry, Psychology and Neuroscience,
King's College London

May 2017

In memory of Nicholas John Mackintosh

1935 – 2015

Acknowledgments

My grateful thanks to my academic supervisors, Dr Colette Hirsh and Dr Charlotte Krahé, for going beyond what I could reasonably have expected of them. I have learnt an enormous amount, and am indebted to them. Many thanks are also due to Professor Andrew Mathews for all his help in developing the ideas for the empirical research project.

Thank you to Jessica Whyte for support with ePrime and a host of other research-related matters, and to Jasmine Vickers and Ania Nowakowska for help with recruitment and data collection.

My friends and family have provided support and tolerance, and have helped make life outside of all this much better.

And thank you to Jane. For all of it.

.

Table of Contents

Systematic Literature Review

Shared and contrasting features of episodes of rumination and worry: A systemic review

Supervisors: Dr Colette Hirsch, Dr Charlotte Krahé

Table of contents

List of tables

List of figures

Abstract

Background: Rumination and worry represent two forms of repetitive negative thinking (RNT) common in mood and anxiety disorders. While they have many similarities, it is unclear whether there are fundamental differences in content, mentation style and functions, or whether these are artefacts of different definitions and research focuses, such that both are fundamentally instances of the same process of RNT. This review aimed to determine whether direct comparisons of episodes of rumination and worry suggest fundamental similarities or differences between them.

Methods: Studies were included if they were empirical studies comparing characteristics of episodes of rumination and worry, either in the context of depression and/or generalised anxiety, or in a non-clinical context. Only studies published in English in peer-reviewed journals were included. Key exclusion criteria included studies solely of trait rumination and worry as measured by standardised questionnaire. Searches were made of PsycINFO, Scopus, Web of Science and PubMed through to March 2017. Quality was assessed using a specifically developed tool.

Results: 9 studies were included, covering both naturally occurring and induced rumination and worry in clinical and non-clinical populations, using experimental and observation methodology. The strongest evidence was for worry being more verbal than rumination, for rumination and worrying containing past-, present- and future-oriented thoughts, and for both leading to a worsening of mood. Rumination and worry are likely to be more abstract than neutral thinking, but the evidence is contradictory as to whether they differ from each other. Rumination emerged as more past-oriented, and worry more future-oriented, but this may be affected by the definitions used. Poorer quality evidence suggested that rumination may be more self-focused, and that there may be greater associations between rumination and sadness, and between worry with anxiety and arousal.

Discussion: This review adds further evidence for a small number of similarities and differences between the rumination and worry that align with findings from separate studies of these forms of RNT, and suggests some difference between the two constructs as they are currently defined. Heterogeneous aims and methodology, contradictory findings and some methodological flaws limited the conclusions that

could be drawn. Definitions of rumination and worry given to participants may have contaminated findings, particularly in relation to temporal orientation. It is unclear whether all studies were examining the same constructs. Future research would benefit from greater clarity about aspects of RNT are being investigated.

1. Introduction

Thinking repeatedly about negative topics is a common feature of many psychological difficulties, particularly (although by no means exclusively) mood and anxiety disorders. Repetitive negative thinking (RNT), defined as "repetitive thinking about one or more negative topics that is experienced as difficult to control" (Ehring & Watkins, 2008, p. 193), has thus been identified as a transdiagnostic process (Harvey, Watkins, Mansell, & Shafran, 2005). What is unclear, however, is the extent to which different forms of RNT represent closely related but fundamentally distinct processes (e.g., Papageorgiou & Wells, 2003; Segerstrom, Stanton, Alden, & Shortridge, 2003), or whether they are essentially broadly the same process examined in slightly different ways in different research contexts (e.g., Beckwé, Deroost, Koster, De Lissnyder, & De Raedt, 2014).

Two of the most commonly studied forms of RNT are rumination and worry. Rumination has been conceptualised in a number of different ways, with some quite marked differences between them, making it difficult to offer a single accepted definition (Smith & Alloy, 2009). Probably the most frequently cited model is that of Nolen-Hoeksema (Nolen-Hoeksema, 1991, 2003; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), whose response styles theory conceptualises rumination as "repetitive and passive thinking about one's symptoms of depression and the possible causes and consequences of these symptoms" (Nolen-Hoeksema, 2003, p. 107) with consequent disruptive impacts on mood, problem-solving and instrumental behaviour.

Worry has been defined as "a chain of thoughts and images, negatively affect-laden and relatively uncontrollable … [that] represents an attempt to engage in mental problem-solving on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes" (Borkovec, Robinson, Pruzinsky, & DePree, 1983, p. 10). Although other conceptualisations of worry exist, they typically focus on these primary characteristics of uncertainty, possible negative outcomes and unpleasantness (Berenbaum, 2010).

1.1. Associations with depression and anxiety

Although rumination has typically been linked to depression, and worry to anxiety (indeed, it forms part of the diagnostic criteria for generalised anxiety disorder [GAD]; American Psychiatric Association, 2013), it is generally accepted that both forms of RNT are common in mood and anxiety disorders. What is less clear is whether there are indeed stronger associations between rumination and depression, and between worry and anxiety. Research examining trait rumination and worry as predictors of depression and anxiety have reached different conclusions, possibly resulting from differences in measures, populations, and approaches to modelling the relationship.

Stronger relationships between trait rumination and depressive symptoms, and trait worry and anxiety symptoms, have been found in populations with current major depressive disorder (MDD) and GAD (Yang et al., 2014), and in non-clinical populations (Hughes, Alloy, & Cogswell, 2008). Meta-analyses have indicated that mood disorders are more strongly associated with rumination than are anxiety disorders (Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013), while severity and frequency of worry (though not its presence *per se*) distinguish anxiety disorders from other conditions (Olatunji, Wolitzky-Taylor, Sawchuk, & Ciesielski, 2010).

A more mixed picture has been found in other studies, for example finding a link between worry and anxiety but not depression and rumination (Muris, Roelofs, Meesters, & Boomsma, 2004), or that worry is associated with both anxious and depressive symptoms, but rumination only with depressive symptoms (Hong, 2007). Other studies again have found no differences: either that rumination and worry are equally associated with depression and anxiety disorders (McEvoy, Watson, Watkins, & Nathan, 2013), or that they are both associated with anxiety symptoms but not depressive symptoms (Calmes & Roberts, 2007).

The extent to which measures of trait rumination and worry overlap may, of course, contribute to the mixed findings. One study found that 84% of the shared variance between rumination and worry overlapped with a separate measure of RNT; nevertheless the unique variance of rumination measures was associated with major depressive disorder (MDD) symptoms only, and the unique variance of worry

measures with GAD symptoms only (Spinhoven, Drost, van Hemert, & Penninx, 2015).

Overall, it appears that a propensity to ruminate tends to be more closely associated with depression, and a propensity to worry tends to be more closely associated with anxiety. However, these findings are not wholly consistent and may vary with populations studied. A more fundamental issue, though, is whether measures of trait rumination and worry are, in fact, genuinely measuring different constructs.

1.2. Factor analyses

Several studies have used factor analysis to examine this question of whether different constructs underlie the trait measures. Again, the studies have been carried out with different populations and, in some cases, different measures and analyses, but in this case have tended to reach broadly similar conclusions.

Three analyses of the two most common measures, the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991) and the Penn State Worry Questionnaire (PSWQ Meyer, Miller, Metzger, & Borkovec, 1990), have found they load onto four factors: two forms of rumination, worry and the absence of worry (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Goring & Papageorgiou, 2008; Yang et al., 2014). Other studies, using different measures, find fewer factors, but still distinguish between rumination and worry (Carney, Harris, Moss, & Edinger, 2010; D'Hudson & Saling, 2010; Muris et al., 2004; Rood, Roelofs, Bogels, & Alloy, 2010). These studies would tend to suggest then, that rumination and worry can be distinguished from each other.

There have been some conflicting findings, however, which have identified a more general RNT factor onto which rumination and worry items both load. One study identified a nested four factor model for the RRS and the PSWQ, with one worry and two rumination factors nested within an RNT factor (McEvoy & Brans, 2013), while another found them to be best modelled by a single RNT factor (Topper, Molenaar, Emmelkamp, & Ehring, 2014).

More generally, the conclusion that rumination and worry are separate constructs on the basis of factor analysis can be challenged on the grounds that the wording of the

measures used maybe introducing additional variance (McEvoy et al., 2013). The RRS is completed with respect to a time "when you feel down, sad, or depressed" and includes items that refer to depression, while every item in the PSWQ makes reference to worry. There is evidence to suggest that this does indeed confound the findings: when items from each (combined with items from additional scales) were reworded to remove references to depression and worry, the resulting RNT questionnaire now loaded a single factor of RNT (McEvoy, Mahoney, & Moulds, 2010).

Although there is evidence to suggest that rumination and worry may be different, then, the studies considered thus far have all taken questionnaire-based measures of the tendency to ruminate and worry as the basis for comparison, and the findings may be affected by the nature and wording of the measures. It is therefore helpful to consider what can be learnt about the actual behaviours of ruminating and worrying through studies of episode of rumination and worry.

1.3. Episodes of rumination and worry

The separate literatures on rumination and worry are wide-ranging, and have encompassed, among other aspects: the content of ruminative and worrisome thinking; the mentation styles involved in each; perceptions of, and beliefs relating to, RNT held by people who ruminate and worry; short-term sequelae (as opposed to the longer-term outcomes of mood and anxiety disorders); and possible functions.

1.3.1. Content

1.3.1.1. Temporal orientation

In the definitions given above, a past and present temporal orientation is implied in the definition of rumination, and a future orientation in the definition of worry, and a distinction is often made between the two in these terms (Nolen-Hoeksema et al., 2008; Papageorgiou & Wells, 2003; Smith & Alloy, 2009). In practice, studies of temporal orientation suggest a less clear-cut distinction.

Studies have identified ruminative thought encompassing past, present and future. In one, rumination about the past was rated as more frequent than present and future, but all three were endorsed (Newby & Moulds, 2012). In another, participants listed rumination topics; of these, many do appear past- and present-oriented, but some are clearly future-oriented (e.g., 'Thinking about the future'; Pearson, Brewin, Rhodes, & McCarron, 2008). For worry, ratings for the proportion or extent of future-focused thoughts may be as low as approximately a half (self-report of worry in general; Borkovec et al., 1983; self-report after induced worry; Frala, Mischel, Knapp, Autry, & Leen-Feldner, 2014) to under one third (experimenter-rated analysis of worry streams; Molina, Borkovec, Peasley, & Person, 1998).

It has been suggested that, despite the apparent overlap, there is a difference in the overall temporal focus of rumination and worry even when they contain elements of past, present and future orientation. For example, a past focus on worry might be driven by concerns for future implications (Berenbaum, 2010). However, it is not clear how rooted in evidence this distinction is.

1.3.1.2. Topics and themes

Rumination is typically said to be focused primarily on the self, involving negative appraisals of one's feelings and situation, and the meanings of these (Nolen-Hoeksema et al., 2008; Papageorgiou & Wells, 2003). In dysphoric people, thinking about the self tends to be negative and self-critical (Lyubomirsky, Tucker, Caldwell, & Berg, 1999), and people with MDD have endorsed a number of negative and self-focused rumination themes (e.g. 'About the kind of person I am' Newby & Moulds, 2012). Chronically depressed participants have reported rumination topics involving negative appraisals and attempts to find meaning, often self-focused, such as "Why did I do this and not something different?", although also some broader topics (e.g., 'The suffering going on in the world'; Pearson et al., 2008).

Although worry is not usually described as self-focused in the way that rumination is, many of the commonly identified worry topics have personal significance (e.g., family and personal relationships, health and injury; Holaway, Rodebaugh, & Heimberg, 2006), and worrying may include a focus on thinking about the implications of events (Behar, Zuellig, & Borkovec, 2005; Hoyer, Becker, & Roth, 2001).

However, even when the broad themes of rumination and worry appear similar, there may be differences in the way these topics are thoughts about. For example, repetitive thinking about problems may focus on self-blame for the problems in rumination (Lyubomirsky et al., 1999), and on attempts to solve problems in worry (Szabó & Lovibond, 2006a).

1.3.2. Mentation style

1.3.2.1. Abstract vs concrete thought

In general, repetitive thinking may be less constructive when it is not only negative but also more abstract and less concrete – that is, more focused on generalities and less focused on specific details (Watkins, 2008). There is evidence to suggest that both rumination (Cribb, Moulds, & Carter, 2006; Goldwin, Behar, & Sibrava, 2013; Watkins & Moulds, 2007) and worry (McGowan et al., 2017; Stöber, 1998) tend to be more abstract. Furthermore, worrying leads to less concrete problem descriptions (Stöber, Tepperwien, & Staak, 2000), and people with GAD describe their problems in less concrete terms than non-anxious people, a difference that is no longer found following successful cognitive therapy (Stöber & Borkovec, 2002).

Although there has been more research into the abstract nature of thinking in worry than in rumination, marked differences between the two have not been explicitly proposed.

1.3.2.2. Verbal thoughts vs imagery

It has been suggested that worry may be characterised by a greater degree of verbal thought than rumination (Papageorgiou & Wells, 2003). There is certainly considerable evidence that verbal thought is more common than imagery in worry (Behar et al., 2005; Borkovec & Inz, 1990; Hirsch, Hayes, Mathews, Perman, & Borkovec, 2012; Hoyer et al., 2001; McGowan et al., 2017).

However, the evidence for rumination is more mixed. One study with chronically depressed participants found that nearly all reported some verbal thought, just over a quarter reported verbal thought only, and the remainder a mixture of verbal thought and sensory imagery (Pearson et al., 2008). Another study with participants with MDD, in contrast, found only 5% reported verbal thoughts only, and and fewer than

half reported some degree of verbal thinking (Newby & Moulds, 2012). Whether rumination and worry differ in this respect therefore remains unclear.

1.3.3. Perceptions and beliefs

Nolen-Hoeksema et al. (2008) have proposed that ruminating is intended, from the person's perspective, to help them to gain insight into the meaning of events and to solve problems, while worrying is intended to prepare for dealing with anticipated threat.

There is indeed evidence to suggest that depressed people believe that rumination helps them understand what has gone wrong and how to make things better or prevent a recurrence (Papageorgiou & Wells, 2001a, 2001b; Watkins & Moulds, 2005). Moreover, endorsement of such beliefs is predictive of a general tendency to ruminate (Weber & Exner, 2013) and of episodes of rumination in day to day life (Kubiak, Zahn, Siewert, Jonas, & Weber, 2014).

There is also evidence from research (Borkovec & Roemer, 1995) and from clinical practice (Borkovec, Hazlett-Stevens, & Diaz, 1999; Dugas, Buhr, & Ladouceur, 2004) to suggest that people with GAD do indeed hold beliefs about worry relevant to threat: that it will help them to avoid bad outcomes or, failing that, to prepare for the worst. However, as with rumination, people may believe that worry helps with solving problems (Borkovec et al., 1999; Borkovec & Roemer, 1995; Dugas et al., 2004; Szabó & Lovibond, 2006b), so the distinction may not be quite as clear cut as Nolen-Hoeksema et al. (2008) propose.

In addition to these positive beliefs, people who ruminate or worry, particularly to excess, often hold a number of negative beliefs about the effects of doing so. Both rumination (Papageorgiou & Wells, 2001a) and worry (Hirsch, Mathews, Lequertier, Perman, & Hayes, 2013; Hoyer et al., 2001; Penney, Mazmanian, & Rudanycz, 2013; Wells, 2006) may be perceived as uncontrollable, damaging, excessive, and likely to interfere with the ability to take action. Rumination may also be perceived as leading to a risk of rejection (Papageorgiou & Wells, 2001a), although this may reflect a more general negative thinking style in depression.

Overall, it appears that there are a number of similarities in the beliefs that people hold about rumination and worry, including about their potential value in helping to

solve problems, and their deleterious effects. There may be differences within this, for example in the extent to which rumination is believed to help gain insight into problems and prevent recurrence, and worry to ward off future threat and problems.

1.3.4. Affective sequelae

Rumination can result in an immediate increase in depressed mood (Ciesla & Roberts, 2007; Park, Goodyer, & Teasdale, 2004), and can prolong existing depressed mood (Huffziger & Kuehner, 2009). It appears rumination leads to worsening of mood in people who are already dysphoric or depressed (Donaldson & Lam, 2004; Lyubomirsky & Nolen-Hoeksema, 1993; Nolen-Hoeksema & Morrow, 1993), although this findings was not replicated in a study with adolescents (Park et al., 2004).

Worry can result in an increase in negative affect (Llera & Newman, 2010), including greater anxiety, distress and depressed mood (Andrews & Borkovec, 1988; Ruscio & Borkovec, 2004), and a range of physiological indictors of a sustained negative emotional state (Newman, Llera, Erickson, Przeworski, & Castonguay, 2013). In a parallel with the effects of rumination on people with pre-existing low mood, it is possible that worry may have a more negative impact on people with GAD (Ruscio & Borkovec, 2004), although this apparent affect may represent higher baseline levels of negative affect (Llera & Newman, 2010)

Rumination and worry thus both have immediate negative effects on mood, and this impact may be greater in clinical populations. There is evidence for worry influencing both depressive and anxious moods, while the effect of rumination on anxious mood does not appear to have attracted research attention, so it is unclear whether they differ in this regard

1.3.5. Functions

Borkovec and colleagues (Borkovec, 1994; Borkovec, Ray, & Stöber, 1998; Sibrava & Borkovec, 2006) have proposed a cognitive avoidance model of worry, in which worry is understood as an attempt to avoid threat. In particular, it is suggested, the less concrete and more verbal natures of worry may interact to facilitate this, with more abstract thinking supporting the avoidance of threatening images. However,

evidence to support the role of verbal worry in reducing negative emotions has not been forthcoming (Hirsch & Mathews, 2012). An alternative contrast avoidance model proposes that worry enables avoidance of emotional contrast for people with GAD – that is, it enables them to stay in a more consistently negative affective state rather than experiencing more variable affect – which could help to explain why people report finding worrying both unpleasant and helpful (Newman & Llera, 2011).

Nolen-Hoeksema et al. (2008) have argued that rumination enables a rather different form of avoidance: a behavioural avoidance of aversive situations and the need to take responsibility for actions. Rumination, they suggest, leads to poorer engagement in problem solving (Lyubomirsky et al., 1999; Watkins & Baracaia, 2002) and a reduced willingness to take part in positive activities (Lyubomirsky & Nolen-Hoeksema, 1993). Moulds et al. (2007), on the other hand, suggest that rumination may also serve a function of cognitive avoidance similar to that proposed for worry; less experimental evidence exists to support this, but associations have been found between trait measures of rumination and cognitive avoidance (Cribb et al., 2006; Moulds et al., 2007).

1.4. Current review

It is clear from the literatures on rumination and worry that these two forms of RNT, both associated with mood and anxiety disorders, are at least very closely related processes. They are both characterised by relatively abstract thinking about problems, typically although not wholly focused on the self. They are experienced as negative and sometimes uncontrollable, and have negative outcomes, and yet are often regarded by those who engage in them frequently as at least somewhat beneficial, particularly in relation to problem-solving. They are both hypothesised to serve a function of avoidance.

There is also evidence to suggest some differences between them. Although both can be focussed on past, present and future concerns, rumination is reported to be more past- and present-oriented overall, and worry more future-oriented. Worry may be characterised by more verbal thinking. Rumination may be perceived more as a tool for understanding problems to prevent recurrence, and worry as a tool for predicting

threat to prevent and mitigate against its occurrence. Rumination may serve to enable more behavioural avoidance, and worry more cognitive avoidance.

What is less clear, though, is how reliable these findings of similarities and differences are. The literature examining rumination and worry separately in some of these areas is sparse, and the findings related to each construct are not wholly consistent, suggesting that differences in population, definitions, study questions and methodology may influence the outcomes. Separate approaches to examining rumination and worry could conceivably contribute to a greater appearance of difference than is truly warranted, and findings could reflect differences in definitions, measures and research focus rather than fundamental underlying differences in process. This is of potential clinical significance: if rumination and worry are fundamentally the same processes, then interventions to target one are likely to be of value in the other, whereas meaningful differences between them may require different approaches to intervention.

This leaves open the question, then, of what direct comparisons between rumination and worry would show in regard to similarities and differences. This is the key question that this review attempts to answer.

1.4.1. Aims

This review aims to answer the question:

- To what extent do direct comparisons of episodes of rumination and worry suggest fundamental similarities or differences between them?

In particular, it seeks to determine whether such comparisons provide insights into similarities or differences relating to:

- The content of thoughts (including but not limited to temporal orientation)
- Mentation styles (including but not limited to abstract or concrete nature, and verbal- or imagery-based nature)
- Perceptions of, and beliefs relating to, rumination and worry
- Short-term sequelae
- Functions

Additionally, it will consider:

- Whether the findings differ for clinical and non-clinical populations

In doing so, the focus will be on rumination and worry in the general population, and in people with depression or GAD, as these are the clinical disorders most closely associated with these forms of RNT.

2. Methods

2.1. Search strategy

Searches were completed in PsycINFO, Scopus, Web of Science and PubMed, using the following search terms in titles, abstracts and keywords:

(ruminat* OR brooding OR "depressive thinking" OR "depressive thought*")

AND (worr* OR "anxious thinking" OR "anxious thought*")

Searches were run in the week beginning 26 December 2016. They were re-run on 4 March 2017, limited to results from 2016-17. Limits were set on the searches as follows: Peer reviewed journal; English language (PsycINFO); Article or Review; Psychology or Social Science; English; Journal (Scopus); Categories - Psychology Clinical, Psychology Multidisciplinary, Psychology, Psychology Experimental, Psychology Biological, Psychology Applied; Document types - Article or Review; Language - English (Web of Science); English, Journal Article (PubMed). A search was made for Medical Subject Headings (MESH) descriptors on PubMed for "worry" and "rumination", but none were found.

Manual searching for additional records was carried out by reviewing the reference sections of all included articles, and by performing Google Scholar citations searches for the included articles.

All article titles were screened, and articles which clearly did not meet the inclusion criteria were screened out. Abstracts of the remaining articles were screened, and those which did not meet the inclusion criteria or clearly met one for more of the exclusion criteria were screened out. The full texts of the remaining articles were retrieved, and each article reviewed again the inclusion and exclusion criteria.

2.2. Inclusion criteria

Articles were included if they met the following criteria, and did not meet the exclusion criteria:

- Empirical studies comparing characteristics of episodes of rumination and worry, either in the context of depression and/or generalised anxiety disorder, or in a non-clinical context
- Studies published in English in a peer-reviewed journal

2.3. Exclusion criteria

Articles were excluded were if they met any of the following criteria:

- Studies solely examining trait rumination and worry as measured by standardised questionnaire
- Studies of depressive or anxious thinking that do not include repetitive negative thought (e.g., single negative automatic thoughts; intrusions)
- Studies of other specific forms of repetitive negative thinking (e.g., angry rumination, anticipatory social anxiety and post-event processing in social anxiety, obsessional thoughts), unless rumination and worry are also included
- Studies of rumination or worry solely in the context of clinical disorders other than depressive disorder or generalised anxiety disorder (e.g., eating disorders, health anxiety, panic disorders, OCD, social phobia, psychosis)
- Clinical studies, case series and case reports of therapies and interventions for rumination and worry, or in which rumination and worry are outcomes measures for the treatment

2.4. Quality assessment

As the studies were highly heterogeneous, no suitable existing quality assessment measure could be found. An assessment tool was therefore developed specially for the review, drawing on a range of existing tools and guidelines (Effective Public Health Practice Project, 1998; i-HOP, 2015; Public Health Wales Observatory, 2014; Rosella et al., 2016; Specialist Unit for Review Evidence (SURE), 2013). Additional

guidance for rating an fMRI study was taken from a set of reporting guidelines widely used for this purpose (Poldrack et al., 2008). Studies were rated on 10 aspects of quality, covering: aims; definitions and operationalising of key concepts; selection, description and grouping of participants; methodology and measurements; data analysis and reporting; and conclusions. Each item was scored on a 3 point scale (0-2), giving a maxim score of 20. The tool is included in the Appendix. As a reliability check, 20% of articles were scored by a second assessor, blind to the first assessor's ratings.

3. Results

3.1. Search results

See Figure 1 for a summary of the search process. The initial search produced 655 results after duplicates were removed. Manual searching of citations yielded one additional study for consideration. After exclusions, 9 papers were included in the final review. Of these, two papers each included two studies (McLaughlin, Borkovec, & Sibrava, 2007; Steinfurth, Alius, Wendt, & Hamm, 2016), and one (Kircanski, Thompson, Sorenson, Sherdell, & Gotlib, 2017) was an analysis of further aspects of the data collected in a another study (Kircanski, Thompson, Sorenson, Sherdell, & Gotlib, 2015). Two studies had primary aims of testing hypotheses relating to rumination (Dickson, Ciesla, & Reilly, 2012) or worry (Steinfurth et al., 2016), but in each case both rumination and worry were included, and comparisons reported, enabling their inclusion in this review.

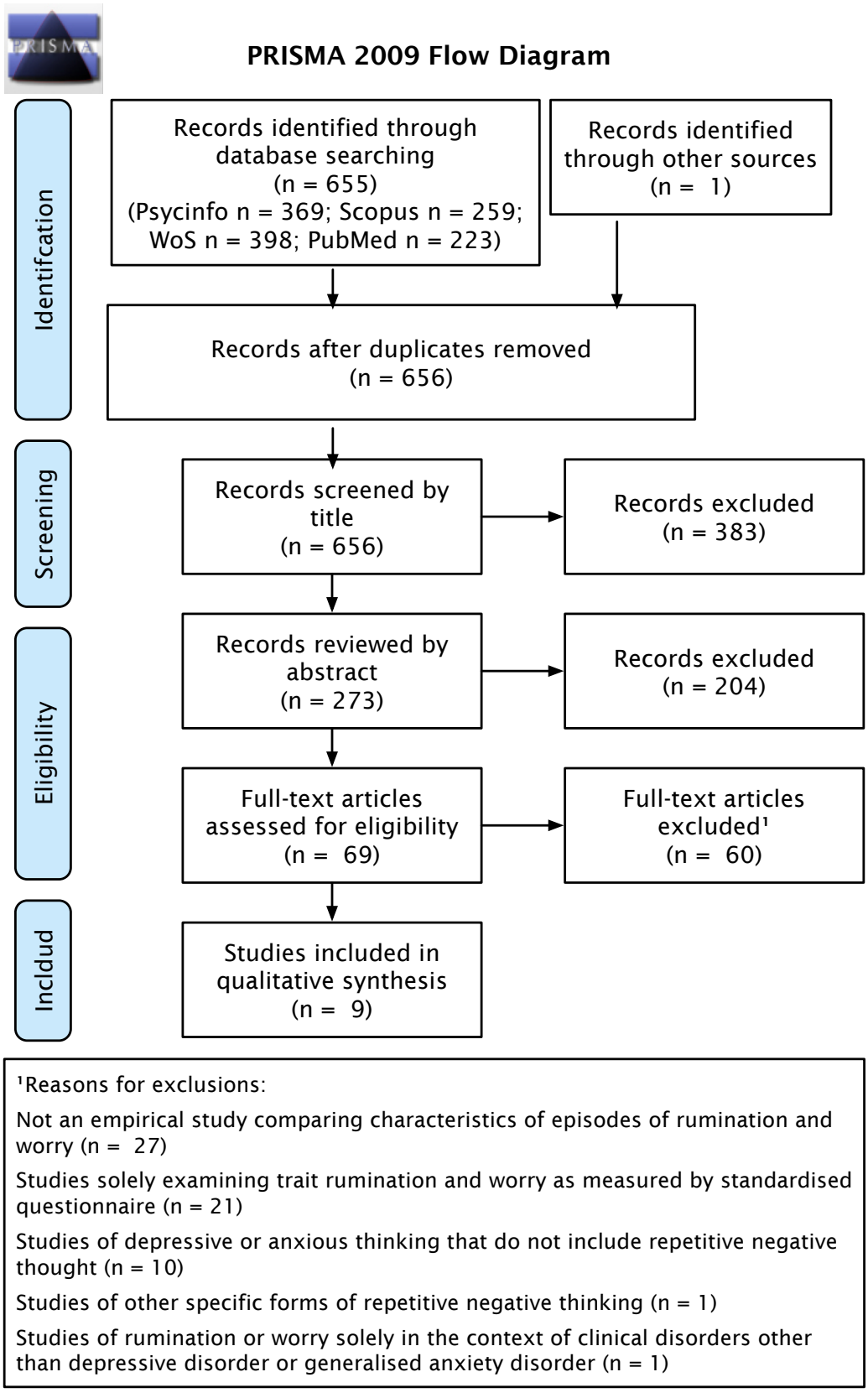
Four of the included studies required careful consideration to determine whether they fit the inclusion criterion of "comparing characteristics of episodes of rumination and worry". Two studies sampled participants' thoughts at moments throughout the day, taking ratings of the extent to which they were ruminating and worrying at that moment (Kircanski et al., 2015, 2017). They may therefore have captured brief automatic thoughts and intrusions at these times. However, longer episodes of repetitive thinking have a greater chance of being sampled, and it was assumed that sufficient repetitive thinking would be included to justify their inclusion.

One study asked participants to rate aspects of instances of "depressive thoughts" and "anxious thoughts" (Papageorgiou & Wells, 1999), which again could include brief automatic thoughts. However, the study reported an average duration of 17 minutes for depressive thoughts, and 15 minutes for anxious thoughts, suggesting that episodes of repetitive thinking were being captured. Similarly, another study examined instances of "thoughts and images" that may not have included repetitive thinking, but reported average durations of 26 minutes for rumination and 11 minutes for worry (Watkins, Moulds, & Mackintosh, 2005).

Additionally, two studies were rejected for not meeting this criterion after particularly detailed consideration. One study used similar methodology to Watkins et al.'s study to identify thoughts; participants then rated the extent to which they used strategies to deal with them. However, in this case the thoughts are described as "intrusions" and no evidence is presented to indicate that they represent longer episodes of relative thinking. Furthermore, the primary data analytic approach is a factor analysis of strategies related to tendencies to ruminate and worry. It was therefore decided that this did not give reliable information on characteristics of episodes of rumination and worry.

The other study asked participants to rate rumination and worry against a number of criteria; no definitions were given of the terms, and there was no requirement to link answers to specific instances of rumination or worry (Hoyer, Gloster, & Herzberg, 2009). Although a number of the criteria were of interest for the review (e.g., temporal orientation), it was decided that the study was examining general understandings of the concepts rather than features of specific episodes of rumination and worry.

Three further studies were excluded because although they collected data on episodes of worry and rumination, these were collapsed into a single category of "perseverative cognition" for analysis, so no comparisons could be made (C. Ottaviani, Medea, Lonigro, Tarvainen, & Couyoumdjian, 2015; Cristina Ottaviani, Shapiro, & Couyoumdjian, 2013; Zoccola, Dickerson, & Yim, 2011).



Adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Figure 1. PRISMA flow diagram of search results

Table 1

Details of included studies

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
Aldao et al. (2013)	Evaluate relationship between heart rate variability (HRV) and rumination & worry	Experimental (within subjects)	"Mulling things over in our heads about things that have happened to us"	'Talking a lot to ourselves about things that we are concerned about happening in the future"	Mood induction: film clips (fear, sadness, happiness) Rated rumination & worry after each, using VAS Standardised HRV measures during films	HRV predicted worry but not rumination Clinical status not significant predictor of worry or rumination	13
Dickson et al. (2012)	Examine temporal relationship between rumination, worry, sadness,	Observational (longitudinal)	Defined by items in modified RRS	Defined by items in modified PSWQ	Daily measures of naturally occurring rumination (RSS[c]) & worry (PSWQ[c]) Additional daily measures of affect (	Rumination predicts increases in sadness & anxiety Worry predicts increase in anxiety	17

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
	anxiety, and avoidance[b]				PANAS-X[c]) & avoidance (CBAS[c])	Cognitive but not behavioural avoidance predicts rumination and worry Additional mediation effects	
Goldwin & Behar (2012)	Examine concreteness of thought in rumination and worry Test association between concreteness and imagery (as test of cognitive	Experimental (within subjects)	"Repetitive, intrusive thoughts about a past event that was distressing but not associated with a traumatic event"	"Repetitive, intrusive thoughts or images about potential future events or catastrophes"	Induced rumination & worry Intermittent reports of thoughts (content, temporal orientation, percentage imagery/verbal)	No significant difference in concreteness Worry more verbal No relationship between concreteness & imagery	15

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
	avoidance theory)				Coded ratings for concreteness of thoughts samples		
Kircanski et al. (2015)	Test for group differences in natural occurring rumination and worry Examine multiple features of rumination and worry	Quasi-experimental (clinical contrasts) Observational (worry / rumination contrasts)	"Dwelling on my feelings and problems"	"Worried about things that could happen"	Momentary prompts 8 x day for 7-8 days for ratings for: Rumination & worry (VAS) Unpleasantness, abstractness (Likert ratings) Repetitiveness, uncontrollability, situational certainty, situational control (VAS)	Rumination and worry in clinical than non-clinical groups; no difference between clinical groups Rumination more past-focused; worry more future-focused Rumination more self-focused Worry more concrete	

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
					Temporal orientation, self-focus, verbal-linguistic focus (fixed choice)		
Kircanski et al. (2017) (n.b. reanalysis of data from Kircanski et al., 2015)	Examine temporal relationships between events, rumination & worry, and affect	Observational (worry / rumination contrasts) Quasi-experimental (clinical contrasts)	"Dwelling on my feelings and problems"	"Worried about things that could happen"	As above for rumination & worry VAS for rumination and worry Rate it significant event occurred since last sample period Aspects of daily events, affect (Likert ratings)	Rumination preceded by significant events that are stressful but less important Worry not related to events Rumination predicts worse affect	19

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
McLaughlin et al. (2007): Study 1	Examine imagery, verbal thought, temporal orientation, & influence on affect	Experimental (within subjects)	"Intrusive thoughts or images about past mistakes or failures that cause negative feelings when they occur"	"Intrusive thoughts or images about potential future events or catastrophes that produce negative feelings when they occur"	Induced rumination & worry Intermittent reports of thoughts (content, temporal orientation, percentage imagery/verbal), affect (PANAS), mood (Likert scales)	Rumination & worry more verbal than imagery Both led to worse mood Rumination more past-oriented, becoming more future-oriented over time Worry more future-oriented	17
McLaughlin et al. (2007): Study 2	As above, and check for group differences in high trait rumination & worry	As above; quasi-experimental for with group contrasts	As above	As above	As above	As above; no group differences	

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
Papageorgiou & Wells (1999)	Compare nature, process and meta-cognitive characteristics of naturally occurring rumination & worry	Observational	"Depressive thoughts"	"Anxious thoughts"	Diary records of 1st two depressive and anxious thoughts in 2 week period Questionnaire ratings for each, including: mood, external/internal trigger, imagery/verbal, controllability, meta-worry, problem-solving	Rumination more past-oriented; no difference on present- or future-orientation Worry more verbal Worry associated with greater effort to solve problems but greater confidence in problem-solving abilities No difference in controllability	15
Steinfurth et al. (2016): Study 1	Test evidence for avoidance and contrast avoidance models of worry	Experimental (within subjects)	"Personal events or topics from the past you currently	"Personal events or topics in the future that you	Induced rumination & worry fMRI scan: BOLD activity	Rumination and worry both associated with activity in regions involved in multiple aspects of	18

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
	via neural correlates (rumination included as comparator condition)		ruminate about"	currently worry about"	Likert scales for mood	emotional processing and imagining emotional events Rumination associated with activity in regions involved in self-referential thinking, and emotional & autobiographic memory Worry more associated with tension and anxiety than rumination	
Steinfurth et al. (2016): Study2	As above with physiological correlates	As above	As above	As above	Induced rumination & worry	Worry associated with stronger startle	

Authors, year	Key objective(s)	Design	Definition of rumination	Definition of worry	Key manipulations and measures	Key findings	Quality score [a]
	(rumination included as comparator condition)				Heart rate (ECG), skin conductance, and response to startle probes (EMG)	response on 1 probe out of 3	
Watkins et al. (2005)	Examine emotions, appraisals and strategies associated with rumination & worry	Experimental (within subjects)	Defined by items from RRS [c] & additional items, preceded by "Thoughts and images"	Defined by items from WDQ[c] preceded by "Thought or images"	Choose single item from each of rumination & worry lists Questionnaire based on CIQ[c]	Worry greater for chronicity, unpleasantness, future orientation, feelings of worry and insecurity Rumination greater for past orientation & reality of problem	15

Notes: [a]Maximum quality score = 20. [b]Relevant objective(s) within broader study. [c]Modified version for the study. PANAS = Positive and Negative Affect Schedule. RRS = Ruminative Responses Scale. VAS = visual analogue scale. WDQ = Worry Domains Questionnaire; CIQ = Cognitive Intrusions Questionnaire

Table 2

Details of participants in included studies

Authors, year	Sample	*N*	Mean age (years)	Female	Subgroups
Aldao et al. (2013)	Community – clinical & non-clinical	68	30.5	(Not reported)	GAD *N* = 38 Major depression *N* = 13
Dickson et al. (2012)	Adolescent, community	101 (78 in final analysis)	16.7	60.7%	(None)
Goldwin & Behar (2012)	Student	117	(Not reported)	56.4%	(None)
Kircanski et al. (2015) Kircanski et al. (2017)	Community & clinical	70	32.9 (clinical); 34.7 (non-clinical)	100%	GAD *N* = 15 MDD *N* = 16 MDD+GAD *N* = 20 No disorder *N* = 19
McLaughlin et al. (2007): Study 1	Student	60		73.3%	(None)

Authors, year	Sample	N	Mean age (years)	Female	Subgroups
McLaughlin et al. (2007): Study 2	Student	109	18.6	75.2%	HW & HR: $N = 34$ HR: $N = 40$ Control $N = 35$
Papageorgiou & Wells (1999)	Student	54	20.7	64.8%	(None)
Steinfurth et al. (2016): Study 1	Student	24 (23 in final analysis)	23.3	50%	(None)
Steinfurth et al. (2016): Study 2	Student	29	29	56.2%	(None)
Watkins et al. (2005)	Mature student	175 (149 in final analysis)	34.9	100%	(None)

3.2. Overview of studies

The studies are extremely heterogeneous in their approaches to comparing rumination and worry, both in terms of the ways in which they accessed information about participants' rumination and worry, and in terms of the focus of the comparisons. A summary of the objectives, design, definitions of rumination and worry, key manipulations and measures used, and key findings of each study is given in Table 1. Participant details are given in Table 2.

3.2.1. Basis for comparisons of rumination and worry

All studies examined differences between rumination and worry within participants. Additionally, four studies made comparisons between subgroups defined by clinical status (Aldao, Mennin, & McLaughlin, 2013; Kircanski et al., 2015, 2017) or trait rumination and worry status (McLaughlin et al., 2007; Study 2) – see Table 1 for details.

3.2.2. Definitions of rumination and worry

The definitions of rumination and worry used in each study are included in Table 1. Studies in seven papers explicitly defined rumination and worry for participants. In doing so, all but one made reference one or more characteristics of rumination and worry: temporal orientation (Aldao et al., 2013; Goldwin & Behar, 2012; Kircanski et al., 2015, 2017; McLaughlin et al., 2007; Steinfurth et al., 2016), valence of thoughts (Aldao et al., 2013; Goldwin & Behar, 2012; Kircanski et al., 2015, 2017; McLaughlin et al., 2007), and verbal–imagery mentation styles (Goldwin & Behar, 2012; McLaughlin et al., 2007).

In two studies, no explicit definitions were given to participants, and rumination and worry were effectively defined by the use of questionnaires to which participants responded. One used forms of the RRS and the PSWQ adapted for daily use (Dickson et al., 2012). The other (Watkins et al., 2005) used forms of the RRS (with items not relating to intrusive thoughts removed, and supplemented by items drawing on previous research into rumination; Watkins & Baracaia, 2001) and the Worry

Domains Questionnaire (WDQ; Tallis, Eysenck, & Mathews, 1992). These definitions include some implication of different temporal orientations (a small number of items in the RRS make reference to the past, and some WDQ items make reference to the future). Additionally, all items in Watkins et al.'s study were modified to begin with the words "Thought or images".

3.2.3. Approaches to investigating rumination and worry

3.2.3.1. Naturally occurring rumination and worry

Four studies examined naturally occurring rumination and worry in day to day life, and one examined rumination and worry as it arose in the laboratory.

Adolescent participants in Dickson et al.'s (2012) study completed records summarising their daily rumination and worry, along with measures of behavioural avoidance, cognitive avoidance and affect, for 7 days. The primary aim was to determine the temporal relationships between avoidance, rumination and affect as a test of an avoidance model of rumination, with worry included to place the findings in a broader context.

Two studies analysed different aspects of the same dataset (Kircanski et al., 2015, 2017). Clinical and non-clinical participants completed visual analogue scales of momentary rumination and worry eight times a day for 7 or 8 days. In the first study (Kircanski et al., 2015), additional measures were taken of various features of ruminative and worrisome thinking hypothesised to be similar or different between the two (e.g., temporal orientation, verbal-linguistic focus). In the second study, at each sampling point participants reported whether any significant events had taken place since the last sampling point, and also reported on current affect, enabling an examination of the temporal relationships between events, rumination and worry, and affect (Kircanski et al., 2017).

In Papageorgiou and Wells' (1999) study, student participants recorded their first two depressed thoughts and first two anxious thoughts in a two week period, to note their content and duration, and rated them on metacognitive beliefs, other features (e.g., temporal orientation, triggers) and related affect.

The laboratory-based study (Aldao et al., 2013) aimed to examine whether rumination and worry vary across emotional contexts, and to evaluate the relationship between rumination and worry and a physiological measure of emotional regulation, heart rate variability (HRV). Clinical and non-clinical participants observed emotional film clips intended to induce happy, sad and fearful moods while having HRV measured. They subsequently reported on the extent to which they had ruminated and worried during the films.

3.2.3.2. Induced rumination and worry

Three papers included studies in which participants were directly instructed to ruminate and worry in the laboratory.

Two studies, which aimed to examine imagery, verbal thought and temporal orientation in rumination and worry, and their influence on affect, are reported by McLaughlin et al. (2007). Student participants completed a baseline period of uninstructed thinking, followed by periods of ruminating and of worrying, and reported intermittently on the content, temporal orientation and verbal/imagery nature of thoughts, along with affect and mood. The second study aimed to replicate the first, and compare findings across groups with differing levels of trait rumination and worry.

Goldwin and Behar's (Goldwin & Behar, 2012) study also used student participants and was closely modelled on McLaughlin et al.'s, taking similar measures. However, the aims were to determine the extent to which rumination and worry are characterised by more abstract thinking, and to test whether reduced concreteness contributes to reduced imagery; experimenters therefore rated the abstractness of reported thought content.

The final paper consisted of two studies aimed to test evidence for the cognitive avoidance (Borkovec, 1994) and contrast avoidance (Llera & Newman, 2010) models of worry by examining neural and physiological correlates of worry (Steinfurth et al., 2016). Rumination was included to provide a basis for comparison with another form of negative thinking. Student participants spent periods of time ruminating, worrying and relaxing. In Study 1, fMRI scans were competed during the different thought

periods, and in Study 2, measures were taken of skin conductance, heart rate, and eyblink responses to acoustic startle probes.

3.2.3.3. Survey

The remaining study did not assess rumination and worry at or soon after the time they occurred (2005). Instead, it used survey methodology to investigate experiences of ruminating and worrying. Mature student participants were given lists of ruminative and worrisome thoughts, and picked a single item from each that best represented their experience or that they thought most about. They completed a questionnaire for each, based on the Cognitive Intrusions Questionnaire (Freeston, Ladouceur, Thibodeau, & Gagnon, 1992), covering appraisals, associated feelings, and strategies for dealing with the thoughts.

3.3. Quality of included studies

Each study was assigned a quality score using the Quality Assessment Tool; these are included in Table 1. Two papers (22% of the total) were rated by a second rater. The intraclass correlation coefficient (ICC) measure of agreement was .44, which is considered "fair" (Cicchetti, 1994).

The validity and reliability of approaches to measurement was an area of relative weakness in most studies. This reflects the lack of standardised tools for measuring episodes of rumination and worry (as opposed to trait rumination and worry). Most studies therefore used specially-developed measures, including visual analogue scales and Likert scales. Inevitably, the reliability and validity of these idiosyncratic measures is not well established, and this was an acknowledged limitation of most studies. Some studies made clear attempts to mitigate this with internal reliability checks, validation against other measures, and similar approaches (Dickson et al., 2012; Kircanski et al., 2015, 2017), whereas others reported few such attempts (Goldwin & Behar, 2012; McLaughlin et al., 2007; Papageorgiou & Wells, 1999; Watkins et al., 2005).

Checks for whether rumination and worry were reliably induced was another relative weakness. One used mood ratings as a manipulation check (Steinfurth et al., 2016), but as rumination and worry are both associated with a range of negative affect, this

may not be reliable measure. One used the reported percentage of past-oriented thought as a manipulation check for rumination, and of future-oriented thought for worry; in both cases this was less than 60%, with no discussion of whether this reflects successful manipulation (Goldwin & Behar, 2012). The final study reported an initial intent to use temporal orientation as the manipulation check, but found an unexpected pattern in which orientation checked during rumination; this was acknowledged as a limitation (McLaughlin et al., 2007; Steinfurth et al., 2016)

One study made multiple comparisons between rumination and worry without correcting statistically for this (Papageorgiou & Wells, 1999). This was reported as a deliberate decision, as such corrections increase the risk of Type II errors, which was felt to be less desirable in an exploratory study. However, this limitation is not acknowledged in the discussion of implications of the results. Findings of significant differences from this study may be less reliable.

In the laboratory study of naturally occurring rumination and worry (Aldao et al., 2013), there were some unexpected findings: levels of rumination and worry during different emotional conditions did not match what might be expected (e.g., worry was not greater during fear induction), and levels overall did not vary between clinical and non-clinical groups. This may suggest that levels of rumination and worry were not being accurately reported, and the findings of this study should be treated with some caution.

None of the studies gave a clear justification for the sample size. The second paper by Kirkanski et al. (2017) referred to a power calculation having been completed to determine the sample size for both studies, but no details are given. It is therefore unclear what effect sizes any of the studies might have been expected to detect. In some cases, the sample sizes appear fairly small, which may have limited their ability to detect small to medium sized effects.

3.4. Synthesis of findings

All studies reported both similarities and differences between rumination and worry.

3.4.1. Content

3.4.1.1. Temporal orientation

Five studies within four papers explicitly investigated differences in temporal orientation. Of these, one study (Papageorgiou & Wells, 1999) made no reference to temporal orientation in the definitions of rumination and worry given to participants; this increases the reliability of these findings, as reporting will not have been influenced by the wording of the definitions. Participants in this study gave ratings for the extent to which their thoughts were past-, present- and future-oriented (i.e., three separate ratings for each thought). Rumination was significantly more past-oriented than worry, but rumination and worry did not differ on the extent to which they were present- or future-oriented. Within each type of RNT, however, the the data shows an unexpected pattern, with rumination appearing being more present- and future-oriented than past, and worry being more present-oriented than future (although no significance tests are reported to confirm this).

In Watkins et al.'s (2005) study, rumination and worry were defined by lists of ruminative and worrisome thought items, some of which implied a temporal orientation. As with the study above, separate ratings were given for the extent to which content was about the past, present and future. Rumination had more past content than worry; worry had more future content. They did not differ on present content. Again, ratings within each type of thought show an unexpected pattern, with both rumination and worry scoring highest for content about the present.

Three studies provided participants with definitions of rumination and worry that included one or more explicit references to temporal orientation. In Kircanski et al.'s (2015) study of naturally occurring rumination and worry, past orientation was a significant predictor of rumination, and future orientation of worry. In both McLaughlin et al.'s (2007) studies, temporal orientation (fixed choice of past, present and future) was reported at each momentary sampling period during induced rumination and worry. Approximately three quarters of thoughts were past-oriented during rumination overall, and future-oriented during worry, although no significance tests are reported. Over all time sampling periods, rumination became significantly more present- and then future-oriented, while no change over time was found for worry.

Additionally, Goldwin and Behar (Goldwin & Behar, 2012) reported on temporal orientation as rated during induced rumination and worry (as a manipulation check, hence no significance tests are reported). 57.5% of worry ratings were future-oriented, and 55.5% of rumination ratings were past-oriented. Their definitions also included reference to temporal orientation.

Overall, these findings give some support to the idea that rumination is more past-oriented, and worry more future-oriented. Temporal orientation may be more subject to change over time within episodes of rumination than within episodes of worry. However, more detailed examination of the data suggests considerable variation of temporal orientation within each construct. Furthermore, the findings must be treated with caution, as they may have been contaminated by the fact that participants in all but one study were given definitions indicative of a temporal orientation.

3.4.1.2. Self-focus

One study directly examined the question of whether rumination is more focused on the self than worry (Kircanski et al., 2015). At each momentary sampling point during this study of naturally occurring rumination and worry, participants rated their thoughts with a forced-choice rating of thoughts being mostly about "myself" or "not myself". More self-focused content was a significant predictor of rumination but not of worry. However, there is a risk that this was contaminated by their definitions, as the definition for rumination was more suggestive of a self focus ("…my feelings and problems") than that for worry ("…things that could happen").

Two other studies report potentially relevant findings. Steinfurth et al. (2016), using fMRI scanning, found that induced rumination, as contrasted with worry, was associated with increased activity in brain regions reported to be involved in self-referential thinking, recall of emotional memory, and context-dependent episodic or autobiographic memory[1]. Watkins et al. (2005) asked participants to rate ruminative and worry topics on the extent to which the content was "personally important", and

[1] The anterior cingulate gyrus, the left amygdala, the DMPFC (medial superior frontal gyrus), the bilateral DLPFC (inferior triangular and opercular frontal gyrus, middle and superior frontal gyrus), and the left hippocampus

found no difference in ratings, but this concept may only only be somewhat tangentially related to self-focus.

Overall, these findings offer preliminary support for a greater self-focus in ruminative thinking, with the possibility that one key result was affected by definitions given to participants.

3.4.2. Mentation style

3.4.2.1. Abstract vs concrete thinking

Two studies reported on the extent to which rumination and worry were characterised by abstract or concrete thinking. In Kircanski et al.'s (Kircanski et al., 2015) study, level of abstractness was not a significant predictor of rumination. Unexpectedly, worry was associated with greater levels of concreteness (in the clinical group only). In contrast, Golden and Behar (2012), who rated samples of thoughts reported during induced rumination and worry, found no significant difference between them for degree of abstractness. They did find both rumination and worry to be more abstract than neutral thought.

As Golden and Behar's study involved more objective ratings of the level of abstraction, overall the findings offer some further support for rumination and worry being more abstract than other forms of thinking. No clear conclusions can be drawn concerning differences between rumination and worry, as the findings are contradictory.

3.4.2.2. Verbal thought vs imagery

Six studies in five papers investigated the extent to which rumination and worry are characterised by primarily verbal thought or by imagery. Of these, three report clear findings for worry being more verbal than rumination. One found that, on a scale of "all images" to "all verbal", naturally occurring worry was rated as further towards the verbal end of the scale than rumination (Papageorgiou & Wells, 1999). In another, a verbal-linguistic focus was a predictor of naturally occurring worry but not rumination (based on a simple forced choice between whether their minds contained primarily 'words' or 'images' at each sampling point; Kircanski et al., 2015). At each sampling point during induced rumination and worry, Goldwin and Behar's (2012)

participants rated the percentage of thoughts and imagery in the preceding period; worry was characterised by less imagery than rumination.

One study found no difference in the ratings given to "percentage of verbal/visual" for rumination and worry (Watkins et al., 2005). As this study did not take ratings at the time of rumination and worry, or soon after, the percentage ratings may have been less accurate in this study.

With regard to whether rumination and worry are both more verbal than other forms of thought, one study reported both to be more verbal than a neutral thinking period (Goldwin & Behar, 2012). Two further studies purport to find that worry involved more verbal-linguistic thought than neutral thinking, while rumination involved more imagery (McLaughlin et al., 2007; Studies 1 & 2); however, the statistical analyses are unclear: very few significance tests are reported, and in Study 1, the difference between rumination and neutral thinking appears very small. Furthermore, although they report in the text that rumination is more visual than neutral thinking in Study 2, the figures they provide suggest the opposite. Their evidence should therefore be considered less than wholly reliable.

Overall, these results offer support for worry being more verbal than rumination. There is also some further evidence for rumination and worry both being more verbal than other types of thought. These findings are unlikely to have been affected by definitions given to participants: studies generally either made no references to thoughts and images (Kircanski et al., 2015; Papageorgiou & Wells, 1999), or referred to them in both definitions (McLaughlin et al., 2007; Watkins et al., 2005). One, in error, referred "thoughts" in the definition of rumination and "thoughts and images" in the definition of worry, but nevertheless reported a greater association between imagery and rumination (Goldwin & Behar, 2012).

3.4.3. Perceptions and beliefs

3.4.3.1. Controllability

Three studies examined participant's perceptions of the controllability of their rumination and worry, with contradictory results that do not enable conclusions to be drawn. One found a difference, with rumination but not worry being predicted by

higher levels of uncontrollability (Kircanski et al., 2015). Two found no differences in ratings of controllability (Papageorgiou & Wells, 1999; Watkins et al., 2005). The latter two studies also found no differences for the possibly related perceptions of rumination and worry as intrusive, voluntary or dismissible (Papageorgiou & Wells, 1999; Watkins et al., 2005), or for the effort or difficulty associated with dismissing the thought (Watkins et al., 2005).

3.4.3.2. Problem-solving

Two studies investigated beliefs about problem-solving in relation to rumination and worry, again with contradictory findings. In one, worry was rated as requiring a greater effort to solve problems but also as associated with greater confidence in problem-solving abilities (Papageorgiou & Wells, 1999). In the other, no differences were found for either of these variables, nor for belief that the problem can be solved (Watkins et al., 2005). It is worth noting that both of these studies investigated a range of perceptions and beliefs about rumination and worry, with many contradictory findings, and no discernible patterns in where they agreed and disagreed. This suggests that methodological differences are likely to have had a significant impact on findings in this area.

3.4.4. Precursors and contexts

Five studies examined one or more aspects of the contexts in which rumination and worry spontaneously occurred and/or their antecedents. One of these (an examination of avoidance as a precursor) is discussed in section 3.4.6 *Functions* below, as its primary aim was to test a theory of the function of rumination (Dickson et al., 2012).

Kircanksi et al. (2015) took ratings of two aspects of the context in which rumination and worry occurred: the extent to which participants "felt a sense of control over situations" and the extent to which they felt "a sense of certainty about situations". As the ratings were made at the same time as the ratings for momentary rumination and worry, it is not possible to clear about whether these feelings preceded or followed the onset of rumination and worry. Their other paper from the same dataset (Kircanski et al., 2017), on the other hand, does enable an examination of the role of preceding events: in addition to reporting on momentary rumination and worry at

eight points during the day, participants also reported on any "significant events" that had occurred since the previous sampling point.

Taken together, their studies show the following patterns for clinical participants. Rumination was preceded by significant events that were rated as stressful but less important, and was associated in the moment with a sense of lack of control over situations. Worry was not preceded by significant events, and was associated with both a sense of lack of control and a sense of uncertainty. For non-clinical participants, the pattern of significant preceding events was reversed, with significant events only predicting worry. While these findings do show both similarities and differences between rumination and worry, an overall coherent pattern does not emerge.

One study examined a single aspect of preceding events: a rating of the extent to which triggers were internal or external (Papageorgiou & Wells, 1999). No difference between rumination and worry was found.

One study enabled a comparison of the effects of induced moods on rumination and worry (Aldao et al., 2013). Participants watched emotional film clips to induce happy, sad and fearful moods, and reported on the extent to which they had ruminated and worried during the films. The only significant findings were that rumination was lower in the fear clip than the sad clip, and worry was lower in the neutral clip than the sad clip. As these results show a somewhat unexpected relationship between mood and thinking, they cast some doubt on the extent to which rumination and worry were occurring during the clips.

Overall, these studies do not suggest any clear patterns of similarities or differences in relation to the contexts in which rumination and worry occur (although also see section 3.4.6 *Functions* below).

3.4.5. Affective sequelae and physiological correlates

Four studies in two papers report on the effects of induced rumination and worry on concurrent mood. All found negative effects of rumination and worry on mood in comparison to neutral control conditions: greater anxiety, depression and tension in one pair of studies (Steinfurth et al., 2016), and greater anxiety, depression and negative affect, and lower positive affect, in the other (McLaughlin et al., 2007).

Additionally, Steinfurth et al. found anxiety and tension to be significantly greater during worry than rumination.

Two studies were designed to be able to make inferences regarding later sequelae. Kircanksi et al. (2017) found that rumination at one sampling period in the day predicted reduced positive and increased negative affect at the next period, for both clinical and non-clinical participants. The only significant finding for worry, on the other hand, was that it predicted greater negative affect in the non-clinical group only. In Dickson et al.'s (2012) study, daily rumination and worry both predicted increases in anxiety on subsequent days, but only rumination predicted sadness. However, this study used a modified form of the RRS for daily rumination which appears to have included three times making specific reference to sadness or depression, which may have confounded the findings.

Two studies examined physiological correlates of rumination and worry.[2] Aldao et al. (2013) reported that lower heart rate variability (as measured by the average of six different heart rate metrics) predicted worry, but not rumination, which might be suggestive of greater arousal in worry. However, it should be noted that rumination and worry were not separately induced – rather, mood was induced, and levels of rumination and worry reported retrospectively, and as noted in section 3.4.5 *Affective sequelae and physiological correlates* above, the associations between mood and type of thought were not as excepted, leading to some uncertainty about the reliability of these findings. Steinfurth et al. (2016; Study 2) in contrast, found no differences in heart rate (rather than HRV) or skin conductance during induced rumination and worry, although they did find a greater startle relax (as measured by eyeblink potentiation) during one of three time points for worry.

Taken together, these results add further evidence for the negative effects of both rumination and worry on mood, with a possible greater association of worry with anxiety and rumination with sadness. They offer some very tentative support for greater arousal during worry than rumination, but the findings are limited and may

[2] See sections 4.1.1.2 *Focus on the self* above, and 4.1.5 *Functions* below, for details of Steinfurth et al.'s (2016) findings relating to neural correlates.

not be reliable. They also suggest the possibility that rumination may have a greater impact than worry on later mood.

3.4.6. Functions

Four studies aimed to test one or more aspects of theories that propose that rumination and/or worry serve a function of enabling avoidance of one type or another. Rumination has been suggested to serve functions of both behavioural avoidance (i.e., avoiding activities; Nolen-Hoeksema et al., 2008) and cognitive avoidance (i.e., avoiding aversive mental states; Moulds et al., 2007). Avoidance theories of worry include a cognitive avoidance theory (e.g., avoiding threat imagery through abstract, verbal thinking; Sibrava & Borkovec, 2006), and a contrast avoidance theory (i.e., avoiding an aversive contrast between negative and positive emotional states by maintaining a negative state much of the time; Newman & Llera, 2011)

Dickson et al. (2012) took daily measures of behavioural and cognitive avoidance, rumination and worry, and sad and anxious mood. The following temporal patterns emerged. Higher levels of cognitive avoidance were followed by higher levels of rumination and worry; they were also followed by greater subsequent sadness and anxiety. Rumination mediated the effect of cognitive avoidance on sadness and anxiety, whereas worry only mediated the effect on anxiety. Behavioural avoidance predicted anxiety only, and there were no mediation effects. They interpret these results as evidence for the cognitive avoidance theory, suggesting that rumination and worry emerge as attempts to avoid distressing internal experiences (by presumed use of an abstract, verbal thinking style), but that attempts to suppress distressing issues prolong repetitive thinking and are ultimately unsuccessful.

Other tests of a cognitive model of avoidance, however, provided little supportive evidence. Goldwin and Behar (2012) aimed to test the cognitive avoidance theory of worry by examining the relationships between verbal and abstract thinking. They predicted that if reduced concreteness enables reduced imagery, an association should be found between low concreteness and low imagery. They found no such association in either worry or rumination. Steinfurth et al. (2016) tested the cognitive and contrast avoidance models by examining neural correlates of worry (with

rumination included as a contrast measure of negative emotional thinking). Using fMRI imaging, they found both rumination and worry to be associated with increased activity in brain regions reported to be involved in processing and imagining emotional events, perception of feelings, and the recall and generation of emotions[3]. They suggest that the evidence for emotional processing supports the contrast avoidance theory, rather than the cognitive avoidance theory (which would predict less emotional processing). Kircanski et al. (2017) tested the contrast avoidance model of worry in GAD, predicting that worry would not be followed by changes in affect if its purpose is to maintain a poor mood at all time. They found this to hold true for the clinical group, which included participants with GAD, but not the non-clinical group.

Overall, these findings offer some limited support for rumination and worry serving a function of avoidance, although none is designed to provide a strong test of theories. The evidence regarding cognitive avoidance is somewhat conflicting: Dickson et al.'s study suggests a potential role for rumination and worry in attempting to prolong cognitive avoidance, while Steinfurth et al. find evidence of emotional processing during rumination and worry, while a proposed association between verbal and abstract thought was not found (Goldwin & Behar, 2012). There is some very limited evidence in support of a contrast avoidance model. As findings are broadly similar for rumination and worry, there is no clear evidence of differences between them. There was no evidence for a function of behavioural avoidance, but no strong tests of this were carried out.

3.4.7. Group differences

Three studies included analyses of differences between clinical and non-clinical samples.

Aldao et al. (2013) found that neither depression nor GAD was a significant predictor of rumination or worry during emotional manipulations. Again, this is an unexpected finding that casts some doubt on the extent to which rumination and worry were accurately measured in the study.

---

[3] The inferior temporal gyrus and the insula

Kircanski et al. (2015, 2017), in contrast, did find higher levels of day to day rumination and worry in clinical participants. They report a a small number of other differences between clinical and non-clinical groups: rumination was more unpleasant for the clinical group, and associated with abstract thought only for the non-clinical group; worry was more strongly associated with a future orientation for the clinical group; as noted above, the pattern of association between significant events and subsequent rumination and worry was reversed; and event stressfulness predicted rumination only for the clinical group. Overall, while there is clear evidence for greater levels of rumination and worry in clinical participants, the findings do not suggest a discernible pattern of differences in the nature of rumination and worry between clinical and non-clinical groups.

One study compared groups with high trait rumination, high trait rumination and worry, and normal levels on both (they were unable to identify a high trait worry only group) (McLaughlin et al., 2007). They reported no differences in relation to temporal orientation, nature of thoughts, or the relationship of rumination and worry with affect.

4. Discussion

This review aimed to determine the extent to which direct comparisons of episodes of rumination and worry suggest fundamental similarities or differences between them. This question is of interest because, while some have argued that that rumination and worry are similar but separate forms of RNT, with distinctive forms, functions and relationships to anxiety and depression (Papageorgiou & Wells, 2003; Segerstrom et al., 2003), others have proposed that they are more likely to represent the same basic process of RNT (e.g., Beckwé et al., 2014; Ehring & Watkins, 2008, p. 193).

The included studies were highly heterogeneous in terms of the populations under study, the specific aims, the conceptualisations and definitions of rumination and worry, and the methodology used to answer the research questions. This has meant that findings have not often converged on a single issue, and are occasionally contradictory, somewhat limiting the answers that can be given. In summary, the strongest findings are that worry is more verbal than rumination, that rumination and worry both contain past-, present- and future-oriented thoughts, and that

rumination and worry are followed by a worsening of mood, both immediately and within the following hours or days. There is some poorer quality evidence for a greater association between rumination and sadness, and between worry and anxiety and arousal. Rumination may be more past-oriented and focused on the self, and worry more future-focused, but these findings may have been affected by definitions given to participants. Both forms are thinking of likely to be more abstract than neutral thinking, but the evidence is contradictory as to whether they differ from each other. Additionally, there is further evidence to suggest that clinical populations experience higher levels of rumination and worry, but there was no clear overall pattern to any differences between RNT in clinical and non-clinical groups.

4.1. Key findings

4.1.1. Content

4.1.1.1. Temporal orientation

Several studies suggested that rumination is more past-oriented, and worry more future-oriented. This is supported by three studies finding significant differences (Kircanski et al., 2015; Papageorgiou & Wells, 1999; Watkins et al., 2005), two studies that report differences without significance tests (Goldwin & Behar, 2012; McLaughlin et al., 2007), and one study showing greater activation of brain regions associated with memory during rumination (Steinfurth et al., 2016). However, none of these studies suggested that rumination and worry had a single temporal orientation; both appeared to contain a mix of past-, present- and future-oriented content. Importantly, the findings risk having been influenced by the fact that all but one study (Papageorgiou & Wells, 1999) included temporal orientation in the definitions of rumination and/or worry given to participants.

4.1.1.2. Focus on the self

There was preliminary evidence for rumination being more self-focused than worry. The most direct evidence comes from a finding of naturally occurring rumination, but not worry, being associated with thoughts rated as being about "myself" (Kircanski et al., 2015), but the definition for rumination in this had a greater focus on self than that for worry. Additionally, an fMRI study showed greater activation in

brain regions associated with self-referential thinking and autobiographical memory during rumination (Steinfurth et al., 2016).

4.1.2. Mentation style

4.1.2.1. Abstract vs concrete thought

There was further evidence to support previous research findings that rumination and worry are more abstract than other forms of thinking, and this comes from experimenter ratings of reported thought content (2012). Evidence on whether rumination and worry differ in this respect was contradictory (Goldwin & Behar, 2012; Kircanski et al., 2015), and no conclusions can be drawn.

4.1.2.2. Verbal thought vs imagery

Probably the strongest finding of the review was that worry appears to be characterised by more verbal and less imagery-based thought than rumination. This conclusion is supported by three studies with widely varying methodologies (Goldwin & Behar, 2012; Kircanski et al., 2015; Papageorgiou & Wells, 1999). Two further studies in one paper purport to show this, although the statistical analyses are unclear (McLaughlin et al., 2007; Studies 1 & 2). This finding is unlikely to have been influenced by definitions given to participants.

4.1.3. Perceptions and beliefs

Findings relating to perceptions of rumination and worry as uncontrollable were too contradictory to enable conclusions to be drawn, as were findings of beliefs about their value in helping solve problems. In general, findings concerning appraisals of rumination and worry were contradictory, suggesting that methodological differences are likely to have had a significant impact on findings.

4.1.4. Affective sequelae and physiological correlates

In line with previous findings, there was evidence for both rumination and worry affecting mood negatively, both at the time (Steinfurth et al., 2016) (McLaughlin et al., 2007) and subsequently (Dickson et al., 2012; Kircanski et al., 2017), with a possibility that rumination has a greater subsequent over longer periods (Kircanski et

al., 2017). Worry, as compared with rumination, may be more strongly associated with anxiety (Steinfurth et al., 2016) and physiological arousal (Aldao et al., 2013; but note that this study had flaws limiting confidence in the conclusions). Rumination may be more associated with sadness, but this may be confounded by the measurement tool (Dickson et al., 2012).

4.1.5. Functions

Overall, support for avoidance theories of rumination and worry was limited and contradictory, and no strong conclusions can be drawn. There was conflicting evidence regarding the idea that worry and rumination enable cognitive avoidance of aversive states. One study (Dickson et al., 2012) found a temporal pattern of higher reported cognitive avoidance predicting subsequent rumination and worry, and also predicting later depressed mood (mediated by rumination) and anxiety (mediated by rumination and worry). It was suggested that this indicates that rumination and worry represent unsuccessful attempts to prolong avoidance (but with some lack of clarity on the mechanism by which this might be working). Other studies variously found evidence for emotional processing during rumination and worry, which suggests that cognitive avoidance is not taking place (Steinfurth et al., 2016), and no evidence for a hypothesised association between verbal and abstract thinking styles that might enable avoidance of aversive imagery (Goldwin & Behar, 2012). This, and a finding that worry did not predict subsequent negative mood (for participants with GAD only; Kircanski et al., 2017), offer more support for a contrast avoidance theory (i.e., maintaining a high level of negative mood to avoid painful contrast with positive mood), but are far from conclusive. As findings were broadly similar for rumination and worry, there is no clear evidence of differences between them.

4.2. Analysis and future directions

Overall, although this review has been able to identify similarities and differences between rumination and worry in a few key areas, it has been difficult to draw very many confident conclusions. Across the studies as a whole there are many findings of differences between the two, but so many comparisons have been made that some may be down to chance, while genuine but smaller effects may have been missed by

underpowered studies. The methodologies and measurements are too varied to allow any form of meta-analysis to overcome these limitations.

One factor that may have led to some of the contradictory findings is the wide variation in how rumination and worry are defined across the studies. This gives rise to two related questions: whether the definitions and instructions given to participants contaminate the findings, and whether the studies are examining the same constructs.

The possible contamination of findings is a particular risk in the findings relating to temporal orientation, given that many of the studies explicitly incorporate this in their definitions. Interestingly, most studies that consider temporal orientation have findings that indicate that both rumination and worry include a mix of past-, present- and future-oriented thoughts. While this is not implausible, it does raise the question of whether research that explicitly defines rumination and worry in terms of their temporal orientation is studying what it intends to.

More generally, this variability in definitions (and also in other aspects of methodology) may mean that the studies are not all examining the same pair of constructs. It is not all clear, for example, that instructing people to report on "mulling things over in our heads about things that have happened to us" (Aldao et al., 2013) and on "depressive thoughts" (Papageorgiou & Wells, 1999), for example, will provide information on the same type of thought processes. Some of the worry item in Watkins et al.'s study (Watkins et al., 2005) more closely resemble the self-focused, past-oriented thought said to characterise rumination (e.g., "that I am not loved", "that I haven't achieved much"), meaning that findings from this study may not generalise to other conceptualisations of rumination and worry.

These difficulties in interpretation point to a more fundamental problem with the question posed, in this review and elsewhere, of whether rumination and worry are essentially the same or different processes. They have been conceptualised, defined, theorised and investigated to some degree in isolation from each other in the literature, and have acquired an accepted set of characteristics as a result that may serve to obscure the exact question being asked. The question "Are rumination and worry different?" potentially conflates several different questions:

- Is RNT about past and present problems different from RNT about future problems?
- Is the RNT that occurs when people feel low in mood different from RNT that occurs when they feel anxious or threatened?
- Is the RNT that leads to depression different from the RNT that leads to anxiety?
- Is self-focused RNT different from RNT focused on external concerns?
- Is RNT that is intended to gain insight into why things happened different from RNT that is intended to prevent future difficulties?

The risk, then, is that studies that suggest evidence for differences between rumination and worry on one of these dimensions are taken as evidence for reliable differences that apply to somewhat different conceptualisations of the two constructs. Future research in this area would therefore benefit from greater clarity on the constructs being examined. This might lead to answers that can better be used to support the development of interventions for RNT in mood and anxiety disorders.

The content of this review is, of course, limited by the content of published papers comparing rumination and worry directly. However, much of the research on rumination and on worry separately, particularly in recent years, has also focused on the underpinning cognitive processes that are believed to play an important role in the development and of maintenance of these forms of thinking. These include emotional processing biases (e.g., attentional biases to negative information, and a tendency to interrupt information negatively), and deficits in working memory, attentional shifting and inhibition (Cohen, Daches, Mor, & Henik, 2014; Hirsch & Mathews, 2012; Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Whitmer & Gotlib, 2013). Direct comparisons of rumination and worry in relation to these processes might offer greater insight into the extent to which they are underpinned by fundamentally similar or different mechanisms, which could also inform the development of appropriate interventions.

5. Limitations

A significant limitation of this review is the quality assessment process. The quality assessment tool was intentionally broad in focus, with general guidelines rather than clearly defined criteria for scoring, in order to allow for rating of heterogeneous studies on a single scale. However, this inevitably increases the subjectivity of the tool, and the discrepancies in ratings for the two papers that were assessed by a second rater suggests that its reliability was not as good as hoped (although the ICC rating was technically considered "fair", at .44 it appears rather low). Moreover, there was no weighting for the separate items. As all papers scored well for many aspects (such as having a clearly defined aim), most papers scored quite highly, and important differences in the quality of methodology and analysis may be have been obscured.

A further limitation is the selection of studies by a single reviewer. As there as some ambiguity in the criterion of "episodes of rumination and worry", as indicated by the need for very close consideration for six papers described in section 3.1 *Results* above, confirmation of inclusion and exclusions decisions, at least for the more marginal decisions, would increase confidence in the decisions.

6. Conclusion

By examining studies that directly compare rumination and worry, this review added further evidence for similarities and differences between the two that align with findings from studies of rumination and worry carried out separately. Overall, it suggests that there are a small number of meaningful differences between the two constructs as they are currently defined. However, very few findings were supported by high quality evidence from multiple studies, and in some cases they were contradicted by findings in other studies within the review. Some findings are likely to have been contaminated by definitions given to participants. The studies were too heterogeneous in terms of methodology, populations, quality and, most importantly, definitions and conceptualisations of rumination and worry, to be able to draw confident conclusions as to whether they are, in essence, instances of the same or different processes.

More fundamentally, conceptualisation of rumination and worry as different constructs is likely to have shaped the findings of much of the literature. There is a risk that findings based on one conceptualisation may be over-extended to other conceptualisations. Future research in this area would benefit from greater clarity about what is being investigated, and how far the findings can be extended to different models of repetitive negative thinking.

7. References

Aldao, A., Mennin, D. S., & McLaughlin, K. A. (2013). Differentiating worry and rumination: Evidence from heart rate variability during spontaneous regulation. *Cognitive Therapy and Research*, *37*(3), 613–619. https://doi.org/10.1007/s10608-012-9485-0

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, D.C.: American Psychiatric Association.

Andrews, V. H., & Borkovec, T. D. (1988). The differential effects of inductions of worry, somatic anxiety, and depression on emotional experience. *Journal of Behavior Therapy and Experimental Psychiatry*, *19*(1), 21–26. https://doi.org/10.1016/0005-7916(88)90006-7

Beckwé, M., Deroost, N., Koster, E. H. W., De Lissnyder, E., & De Raedt, R. (2014). Worrying and rumination are both associated with reduced cognitive control. *Psychological Research*, *78*(5), 651–660. https://doi.org/10.1007/s00426-013-0517-5

Behar, E., Zuellig, A. R., & Borkovec, T. D. (2005). Thought and imaginal activity during worry and trauma recall. *Behavior Therapy*, *36*(2), 157–168. https://doi.org/10.1016/S0005-7894(05)80064-4

Berenbaum, H. (2010). An initiation–termination two-phase model of worrying. *Clinical Psychology Review*, *30*(8), 962–975. https://doi.org/10.1016/j.cpr.2010.06.011

Borkovec, T. D. (1994). The nature, functions, and origins of worry. In G. Davey & F. Tallis (Eds.), *Worrying: perspectives on theory, assessment, and treatment* (pp. 5–33). Chichester, England: John Wiley.

Borkovec, T. D., Hazlett-Stevens, H., & Diaz, M. L. (1999). The role of positive beliefs about worry in generalized anxiety disorder and its treatment. *Clinical*

Psychology & Psychotherapy, *6*(2), 126–138. https://doi.org/10.1002/(SICI)1099-0879(199905)6:2<126::AID-CPP193>3.0.CO;2-M

Borkovec, T. D., & Inz, J. (1990). The nature of worry in generalized anxiety disorder: A predominance of thought activity. *Behaviour Research and Therapy*, *28*(2), 153–158. https://doi.org/10.1016/0005-7967(90)90027-G

Borkovec, T. D., Ray, W. J., & Stöber, J. (1998). Worry: A cognitive phenomenon intimately linked to affective, physiological, and interpersonal behavioral processes. *Cognitive Therapy and Research*, *22*(6), 561–576. https://doi.org/10.1023/A:1018790003416

Borkovec, T. D., Robinson, E., Pruzinsky, T., & DePree, J. A. (1983). Preliminary exploration of worry: Some characteristics and processes. *Behaviour Research and Therapy*, *21*(1), 9–16. https://doi.org/10.1016/0005-7967(83)90121-3

Borkovec, T. D., & Roemer, L. (1995). Perceived functions of worry among generalized anxiety disorder subjects: Distraction from more emotionally distressing topics? *Journal of Behavior Therapy and Experimental Psychiatry*, *26*(1), 25–30. https://doi.org/10.1016/0005-7916(94)00064-S

Calmes, C. A., & Roberts, J. E. (2007). Repetitive thought and emotional distress: Rumination and worry as prospective predictors of depressive and anxious symptomatology. *Cognitive Therapy and Research*, *31*(3), 343–356. https://doi.org/10.1007/s10608-006-9026-9

Carney, C. E., Harris, A. L., Moss, T. G., & Edinger, J. D. (2010). Distinguishing rumination from worry in clinical insomnia. *Behaviour Research and Therapy*, *48*(6), 540–546. https://doi.org/10.1016/j.brat.2010.03.004

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychological Assessment*, *6*(4), 284–290. https://doi.org/10.1037/1040-3590.6.4.284

Ciesla, J. A., & Roberts, J. E. (2007). Rumination, negative cognition, and their interactive effects on depressed mood. *Emotion*, *7*(3), 555–565. https://doi.org/10.1037/1528-3542.7.3.555

Cohen, N., Daches, S., Mor, N., & Henik, A. (2014). Inhibition of negative content—a shared process in rumination and reappraisal. *Emotion Science*, *5*, 622. https://doi.org/10.3389/fpsyg.2014.00622

Cribb, G., Moulds, M. L., & Carter, S. (2006). Rumination and experiential avoidance in depression. *Behaviour Change*, *23*(3), 165–176. https://doi.org/10.1375/bech.23.3.165

D'Hudson, G., & Saling, L. L. (2010). Worry and rumination in older adults: Differentiating the processes. *Aging and Mental Health*, *14*(5), 524–534. https://doi.org/10.1080/13607861003713141

Dickson, K. S., Ciesla, J. A., & Reilly, L. C. (2012). Rumination, worry, cognitive avoidance, and behavioral avoidance: Examination of temporal effects. *Behavior Therapy*, *43*(3), 629–640. https://doi.org/10.1016/j.beth.2011.11.002

Donaldson, C., & Lam, D. (2004). Rumination, mood and social problem-solving in major depression. *Psychological Medicine*, *34*(7), 1309–1318. https://doi.org/10.1017/S0033291704001904

Dugas, M. J., Buhr, K., & Ladouceur, R. (2004). The role of intolerance of uncertainty in etiology and maintenance. In R. G. Heimberg, C. L. Turk, & D. S. Mennin (Eds.), *Generalized anxiety disorder: Advances in research and practice* (pp. 143–163). New York, NY, US: Guilford Press.

Effective Public Health Practice Project. (1998). *Quality Assessment Tool for Quantitative Studies*. Hamilton, Canada: Author. Retrieved from http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy*, *1*(3), 192–205. https://doi.org/10.1521/ijct.2008.1.3.192

Frala, J., Mischel, E., Knapp, A., Autry, K., & Leen-Feldner, E. (2014). Adolescent worry induction: An experimental laboratory evaluation. *Journal of Experimental Psychopathology*, *5*(1), 52–71. https://doi.org/10.5127/jep.033912

Freeston, M. H., Ladouceur, R., Thibodeau, N., & Gagnon, F. (1992). Cognitive intrusions in a non-clinical population. II. Associations with depressive, anxious, and compulsive symptoms. *Behaviour Research and Therapy*, *30*(3), 263–271. https://doi.org/10.1016/0005-7967(92)90072-O

Fresco, D. M., Frankel, A. N., Mennin, D. S., Turk, C. L., & Heimberg, R. G. (2002). Distinct and overlapping features of rumination and worry: The relationship of cognitive production to negative affective states. *Cognitive Therapy and Research*, *26*(2), 179–188. https://doi.org/10.1023/A:1014517718949

Goldwin, M., & Behar, E. (2012). Concreteness of idiographic periods of worry and depressive rumination. *Cognitive Therapy and Research*, *36*(6), 840–846. https://doi.org/10.1007/s10608-011-9428-1

Goldwin, M., Behar, E., & Sibrava, N. (2013). Concreteness of depressive rumination and trauma recall in individuals with elevated trait rumination and/or posttraumatic stress symptoms. *Cognitive Therapy and Research*, *37*(4), 680–689. https://doi.org/10.1007/s10608-012-9507-y

Goring, H. J., & Papageorgiou, C. (2008). Rumination and worry: Factor analysis of self-report measures in depressed participants. *Cognitive Therapy and Research*, *32*(4), 554–566. https://doi.org/10.1007/s10608-007-9146-x

Harvey, A., Watkins, E., Mansell, W., & Shafran, R. (2005). *Cognitive behavioural processes across psychological disorders: A transdiagnostic approach to research and treatment*. Oxford ; New York: Oxford University Press, U.S.A.

Hirsch, C. R., Hayes, S., Mathews, A., Perman, G., & Borkovec, T. (2012). The extent and nature of imagery during worry and positive thinking in generalized anxiety disorder. *Journal of Abnormal Psychology*, *121*(1), 238–243. https://doi.org/10.1037/a0024947

Hirsch, C. R., & Mathews, A. (2012). A cognitive model of pathological worry. *Behaviour Research and Therapy*, *50*(10), 636–646. https://doi.org/10.1016/j.brat.2012.06.007

Hirsch, C. R., Mathews, A., Lequertier, B., Perman, G., & Hayes, S. (2013). Characteristics of worry in Generalized Anxiety Disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(4), 388–395. https://doi.org/10.1016/j.jbtep.2013.03.004

Holaway, R. M., Rodebaugh, T. L., & Heimberg, R. G. (2006). The epidemiology of worry and generalized anxiety disorder. In G. C. L. Davey & A. Wells (Eds.), *Worry and its Psychological Disorders* (pp. 1–20). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713143.ch1

Hong, R. Y. (2007). Worry and rumination: Differential associations with anxious and depressive symptoms and coping behavior. *Behaviour Research and Therapy*, *45*(2), 277–290. https://doi.org/10.1016/j.brat.2006.03.006

Hoyer, J., Becker, E. S., & Roth, W. T. (2001). Characteristics of worry in GAD patients, social phobics and controls. *Depression and Anxiety*, *13*(2), 89–96. https://doi.org/10.1002/da.1021

Hoyer, J., Gloster, A. T., & Herzberg, P. Y. (2009). Is worry different from rumination? Yes, it is more predictive of psychopathology! *GMS Psycho-Social-Medicine*. https://doi.org/10.3205/psm000062

Huffziger, S., & Kuehner, C. (2009). Rumination, distraction, and mindful self-focus in depressed patients. *Behaviour Research and Therapy*, *47*(3), 224–230. https://doi.org/10.1016/j.brat.2008.12.005

Hughes, M. E., Alloy, L. B., & Cogswell, A. (2008). Repetitive thought in psychopathology: The relation of rumination and worry to depression and anxiety symptoms. *Journal of Cognitive Psychotherapy*, *22*(3), 271–288. https://doi.org/10.1891/0889-8391.22.3.271

i-HOP. (2015). *i-HOP's Quality Assessment Tool for research and evidence around children of offenders*. Ilford, England: Author. Retrieved from https://www.i-hop.org.uk/app/answers/detail/a_id/726

Kircanski, K., Thompson, R. J., Sorenson, J. E., Sherdell, L., & Gotlib, I. H. (2015). Rumination and worry in daily life: Examining the naturalistic validity of theoretical constructs. *Clinical Psychological Science*, *3*(6), 926–939. https://doi.org/10.1177/2167702614566603

Kircanski, K., Thompson, R. J., Sorenson, J., Sherdell, L., & Gotlib, I. H. (2017). The everyday dynamics of rumination and worry: Precipitant events and affective consequences. *Cognition & Emotion*, 1–13. https://doi.org/10.1080/02699931.2017.1278679

Koster, E. H. W., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review*, *31*(1), 138–145. https://doi.org/10.1016/j.cpr.2010.08.005

Kubiak, T., Zahn, D., Siewert, K., Jonas, C., & Weber, H. (2014). Positive beliefs about rumination are associated with ruminative thinking and affect in daily life: evidence for a metacognitive view on depression. *Behavioural and Cognitive Psychotherapy*, *42*(5), 568–576. https://doi.org/10.1017/S1352465813000325

Llera, S. J., & Newman, M. G. (2010). Effects of worry on physiological and subjective reactivity to emotional stimuli in generalized anxiety disorder and nonanxious control participants. *Emotion*, *10*(5), 640–650. https://doi.org/10.1037/a0019351

Lyubomirsky, S., & Nolen-Hoeksema, S. (1993). Self-perpetuating properties of dysphoric rumination. *Journal of Personality and Social Psychology*, *65*(2), 339–349. https://doi.org/10.1037/0022-3514.65.2.339

Lyubomirsky, S., Tucker, K. L., Caldwell, N. D., & Berg, K. (1999). Why ruminators are poor problem solvers: Clues from the phenomenology of dysphoric rumination. *Journal of Personality and Social Psychology*, *77*(5), 1041–1060. https://doi.org/10.1037/0022-3514.77.5.1041

McEvoy, P. M., & Brans, S. (2013). Common versus unique variance across measures of worry and rumination: Predictive utility and mediational models for anxiety and depression. *Cognitive Therapy and Research*, *37*(1), 183–196. https://doi.org/10.1007/s10608-012-9448-5

McEvoy, P. M., Mahoney, A. E. J., & Moulds, M. L. (2010). Are worry, rumination, and post-event processing one and the same? Development of the repetitive thinking questionnaire. *Journal of Anxiety Disorders*, *24*(5), 509–519. https://doi.org/10.1016/j.janxdis.2010.03.008

McEvoy, P. M., Watson, H., Watkins, E. R., & Nathan, P. (2013). The relationship between worry, rumination, and comorbidity: Evidence for repetitive negative thinking as a transdiagnostic construct. *Journal of Affective Disorders*, *151*(1), 313–320. https://doi.org/10.1016/j.jad.2013.06.014

McGowan, S. K., Stevens, E. S., Behar, E., Judah, M. R., Mills, A. C., & Grant, D. M. (2017). Concreteness of idiographic worry and anticipatory processing. *Journal of Behavior Therapy and Experimental Psychiatry*, *54*, 195–203. https://doi.org/10.1016/j.jbtep.2016.08.005

McLaughlin, K. A., Borkovec, T. D., & Sibrava, N. J. (2007). The effects of worry and rumination on affect states and cognitive activity. *Behavior Therapy*, *38*(1), 23–38. https://doi.org/10.1016/j.beth.2006.03.003

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, *28*(6), 487–495. https://doi.org/10.1016/0005-7967(90)90135-6

Molina, S., Borkovec, T. D., Peasley, C., & Person, D. (1998). Content analysis of worrisome streams of consciousness in anxious and dysphoric participants. *Cognitive Therapy and Research*, *22*(2), 109–123. https://doi.org/10.1023/A:1018772104808

Moulds, M. L., Kandris, E., Starr, S., & Wong, A. C. M. (2007). The relationship between rumination, avoidance and depression in a non-clinical sample. *Behaviour Research and Therapy*, *45*(2), 251–261. https://doi.org/10.1016/j.brat.2006.03.003

Muris, P., Roelofs, J., Meesters, C., & Boomsma, P. (2004). Rumination and worry in nonclinical adolescents. *Cognitive Therapy and Research*, *28*(4), 539–554. https://doi.org/10.1023/B:COTR.0000045563.66060.3e

Newby, J. M., & Moulds, M. L. (2012). A comparison of the content, themes, and features of intrusive memories and rumination in major depressive disorder. *Journal of Clinical Psychology*, *51*(2), 197–205. https://doi.org/10.1111/j.2044-8260.2011.02020.x

Newman, M. G., & Llera, S. J. (2011). A novel theory of experiential avoidance in generalized anxiety disorder: A review and synthesis of research supporting a contrast avoidance model of worry,. *Clinical Psychology Review*, *31*(3), 371–382. https://doi.org/10.1016/j.cpr.2011.01.008

Newman, M. G., Llera, S. J., Erickson, T. M., Przeworski, A., & Castonguay, L. G. (2013). Worry and generalized anxiety disorder: A review and theoretical synthesis of evidence on nature, etiology, mechanisms, and treatment. *Annual Review of Clinical Psychology*, *9*, 275–297. https://doi.org/10.1146/annurev-clinpsy-050212-185544

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, *100*(4), 569–582. https://doi.org/10.1037/0021-843X.100.4.569

Nolen-Hoeksema, S. (2003). The response styles theory. In C. Papageorgiou & A. Wells (Eds.), *Depressive rumination* (pp. 105–123). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713853.ch6

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: The 1989 Loma Prieta Earthquake. *Journal of Personality and Social Psychology*, *61*(1), 115–121. https://doi.org/10.1037/0022-3514.61.1.115

Nolen-Hoeksema, S., & Morrow, J. (1993). Effects of rumination and distraction on naturally occurring depressed mood. *Cognition and Emotion*, *7*(6), 561–570. https://doi.org/10.1080/02699939308409206

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*(5), 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

Olatunji, B. O., Naragon-Gainey, K., & Wolitzky-Taylor, K. B. (2013). Specificity of rumination in anxiety and depression: A multimodal meta-analysis. *Clinical Psychology: Science and Practice*, *20*(3), 225–257. https://doi.org/10.1111/cpsp.12037

Olatunji, B. O., Wolitzky-Taylor, K. B., Sawchuk, C. N., & Ciesielski, B. G. (2010). Worry and the anxiety disorders: A meta-analytic synthesis of specificity to GAD. *Applied and Preventive Psychology*, *14*(1–4), 1–24. https://doi.org/10.1016/j.appsy.2011.03.001

Ottaviani, C., Medea, B., Lonigro, A., Tarvainen, M., & Couyoumdjian, A. (2015). Cognitive rigidity is mirrored by autonomic inflexibility in daily life perseverative cognition. *Biological Psychology*, *107*, 24–30. https://doi.org/10.1016/j.biopsycho.2015.02.011

Ottaviani, Cristina, Shapiro, D., & Couyoumdjian, A. (2013). Flexibility as the key for somatic health: From mind wandering to perseverative cognition. *Biological Psychology*, *94*(1), 38–43. https://doi.org/10.1016/j.biopsycho.2013.05.003

Papageorgiou, C., & Wells, A. (1999). Process and meta-cognitive dimensions of depressive and anxious thoughts and relationships with emotional intensity. *Clinical Psychology & Psychotherapy*, *6*(2), 156–162. https://doi.org/10.1002/(SICI)1099-0879(199905)6:2<156::AID-CPP196>3.0.CO;2-A

Papageorgiou, C., & Wells, A. (2001a). Metacognitive beliefs about rumination in recurrent major depression. *Cognitive and Behavioral Practice*, *8*(2), 160–164. https://doi.org/10.1016/S1077-7229(01)80021-3

Papageorgiou, C., & Wells, A. (2001b). Positive beliefs about depressive rumination: Development and preliminary validation of a self-report scale. *Behavior Therapy*, *32*(1), 13–26. https://doi.org/10.1016/S0005-7894(01)80041-1

Papageorgiou, C., & Wells, A. (2003). Nature, functions, and beliefs about depressive rumination. In C. Papageorgiou & A. Wells (Eds.), *Depressive rumination* (pp. 1–20). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713853.ch1

Park, R. J., Goodyer, I. M., & Teasdale, J. D. (2004). Effects of induced rumination and distraction on mood and overgeneral autobiographical memory in

adolescent Major Depressive Disorder and controls. *Journal of Child Psychology and Psychiatry*, *45*(5), 996–1006. https://doi.org/10.1111/j.1469-7610.2004.t01-1-00291.x

Pearson, M., Brewin, C. R., Rhodes, J., & McCarron, G. (2008). Frequency and nature of rumination in chronic depression: A preliminary study. *Cognitive Behaviour Therapy*, *37*(3), 1–9. https://doi.org/10.1080/16506070801919224

Penney, A. M., Mazmanian, D., & Rudanycz, C. (2013). Comparing positive and negative beliefs about worry in predicting generalized anxiety disorder symptoms. *Journal of Behavioural Science*, *45*(1), 34–41. https://doi.org/10.1037/a0027623

Poldrack, R. A., Fletcher, P. C., Henson, R. N., Worsley, K. J., Brett, M., & Nichols, T. E. (2008). Guidelines for reporting an fMRI study. *NeuroImage*, *40*(2), 409–414. https://doi.org/10.1016/j.neuroimage.2007.11.048

Public Health Wales Observatory. (2014). *Questions to assist with the critical appraisal of a cross-sectional study (Type IV evidence)*. Carmarthen, Wales: Author. Retrieved from www2.nphs.wales.nhs.uk

Rood, L., Roelofs, J., Bogels, S. M., & Alloy, L. B. (2010). Dimensions of negative thinking and the relations with symptoms of depression and anxiety in children and adolescents. *Cognitive Therapy and Research*, *34*(4), 333–342. https://doi.org/10.1007/s10608-009-9261-y

Rosella, L., Bowman, C., Pach, B., Morgan, S., Fitzpatrick, T., & Goel, V. (2016). The development and validation of a meta-tool for quality appraisal of public health evidence: Meta Quality Appraisal Tool (MetaQAT). *Public Health*, *136*, 57–65. https://doi.org/10.1016/j.puhe.2015.10.027

Ruscio, A. M., & Borkovec, T. D. (2004). Experience and appraisal of worry among high worriers with and without generalized anxiety disorder. *Behaviour Research and Therapy*, *42*(12), 1469–1482. https://doi.org/10.1016/j.brat.2003.10.007

Segerstrom, S. C., Stanton, A. L., Alden, L. E., & Shortridge, B. E. (2003). A multidimensional structure for repetitive thought: What's on your mind, and how, and how much? *Journal of Personality*, *85*(5), 909–921. https://doi.org/10.1037/0022-3514.85.5.909

Sibrava, N. J., & Borkovec, T. d. (2006). The cognitive avoidance theory of worry. In G. C. L. Davey & A. Wells (Eds.), *Worry and its psychological disorders* (pp. 239–256). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713143.ch14

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review*, *29*(2), 116–128. https://doi.org/10.1016/j.cpr.2008.10.003

Specialist Unit for Review Evidence (SURE). (2013). *Questions to assist with the critical appraisal of randomised controlled trials and other experimental studies*. Cardiff, Wales: Author. Retrieved from http://www.cardiff.ac.uk/insrv/libraries/sure/doc/SURE_RCT_Checklist_2013.pdf

Spinhoven, P., Drost, J., van Hemert, B., & Penninx, B. W. (2015). Common rather than unique aspects of repetitive negative thinking are related to depressive and anxiety disorders and symptoms. *Journal of Anxiety Disorders*, *33*, 45–52. https://doi.org/10.1016/j.janxdis.2015.05.001

Steinfurth, E. C. K., Alius, M. G., Wendt, J., & Hamm, A. O. (2016). Physiological and neural correlates of worry and rumination: Support for the contrast avoidance model of worry. *Psychophysiology*. https://doi.org/10.1111/psyp.12767

Stöber, J. (1998). Worry, problem elaboration and suppression of imagery: The role of concreteness. *Behaviour Research and Therapy*, *36*(7–8), 751–756. https://doi.org/10.1016/S0005-7967(98)00027-8

Stöber, J., & Borkovec, T. D. (2002). Reduced concreteness of worry in generalized anxiety disorder: Findings from a therapy study. *Cognitive Therapy and Research*, *26*(1), 89–96. https://doi.org/10.1023/A:1013845821848

Stöber, J., Tepperwien, S., & Staak, M. (2000). Worrying leads to reduced concreteness of problem elaborations: Evidence for the avoidance theory of worry. *Anxiety, Stress, & Coping*, *13*(3), 217–227. https://doi.org/10.1080/10615800008549263

Szabó, M., & Lovibond, P. F. (2006a). Worry episodes and perceived problem solving: A diary-based approach. *Anxiety, Stress and Coping*, *19*(2), 175–187. https://doi.org/10.1080/10615800600643562

Szabó, M., & Lovibond, P. F. (2006b). Worry episodes and perceived problem solving: A diary-based approach. *Anxiety, Stress and Coping*, *19*(2), 175–187. https://doi.org/10.1080/10615800600643562

Tallis, F., Eysenck, M., & Mathews, A. (1992). A questionnaire for the measurement of nonpathological worry. *Personality and Individual Differences*, *13*(2), 161–168. https://doi.org/10.1016/0191-8869(92)90038-Q

Topper, M., Molenaar, D., Emmelkamp, P., & Ehring, T. (2014). Are rumination and worry two sides of the same coin? A structural equation modelling approach. *Journal of Experimental Psychopathology*, *5*(3), 363–381. https://doi.org/10.5127/jep.038813

Watkins, E. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin*, *134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163

Watkins, E., & Baracaia, S. (2001). Why do people ruminate in dysphoric moods? *Personality and Individual Differences*, *30*(5), 723–734. https://doi.org/10.1016/S0191-8869(00)00053-2

Watkins, E., & Baracaia, S. (2002). Rumination and social problem-solving in depression. *Behaviour Research and Therapy*, *40*(10), 1179–1189. https://doi.org/10.1016/S0005-7967(01)00098-5

Watkins, E., & Moulds, M. (2005). Positive beliefs about rumination in depression—a replication and extension. *Personality and Individual Differences*, *39*(1), 73–82. https://doi.org/10.1016/j.paid.2004.12.006

Watkins, E., & Moulds, M. L. (2007). Reduced concreteness of rumination in depression: A pilot study. *Personality and Individual Differences*, *43*(6), 1386–1395. https://doi.org/10.1016/j.paid.2007.04.007

Watkins, E., Moulds, M., & Mackintosh, B. (2005). Comparisons between rumination and worry in a non-clinical population. *Behaviour Research and Therapy*, *43*(12), 1577–1585. https://doi.org/10.1016/j.brat.2004.11.008

Weber, F., & Exner, C. (2013). Metacognitive beliefs and rumination: A longitudinal study. *Cognitive Therapy and Research*, *37*(6), 1257–1261. https://doi.org/10.1007/s10608-013-9555-y

Wells, A. (2006). The metacognitive model of worry and generalised anxiety disorder. In G. C. L. Davey & A. Wells (Eds.), *Worry and its psychological disorders* (pp. 177–199). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713143.ch11

Whitmer, A. J., & Gotlib, I. H. (2013). An attentional scope model of rumination. *Psychological Bulletin*, *139*(5), 1036–1061. https://doi.org/10.1037/a0030923

Yang, M.-J., Kim, B.-N., Lee, E.-H., Lee, D., Yu, B.-H., Jeon, H. J., & Kim, J.-H. (2014). Diagnostic utility of worry and rumination: a comparison between generalized anxiety disorder and major depressive disorder. *Psychiatry and Clinical Neurosciences*, *68*(9), 712–720. https://doi.org/10.1111/pcn.12193

Zoccola, P. M., Dickerson, S. S., & Yim, I. S. (2011). Trait and state perseverative cognition and the cortisol awakening response. *Psychoneuroendocrinology*, *36*(4), 592–595. https://doi.org/10.1016/j.psyneuen.2010.10.004

Appendix: Quality Assessment Tool

Systematic Literature Review: Quality Assessment Tool

The bullet points are indicators of the quality level. Not all bullet points will be applicable to each study, but should give a general idea of the standard required

Study		**Total score:** /20
Scored by:		**Date:**

1. The study addresses one or more clearly focused questions/hypotheses	**Score:**
2: Yes	• Clearly and unambiguously stated • Enables study to be designed to answer questions / test hypotheses • Primary outcomes can be clearly determined
1: Reservations	• Some lack of clarity regarding questions/hypotheses • Reasonably questions/hypotheses, but primary outcomes cannot be clearly determined
0: No	• Not possible to determine what questions/hypotheses the study is addressing
Notes	

2. Key concepts are clearly and appropriately defined and operationalised	**Score:**
2: Yes	• Explicit definition of key comparator concepts (worry, rumination) • Clear justification for definitions • Links to theory and literature • Operationalisation is unambiguous and enables clear distinction between variables • Participants are likely to be able to distinguish between comparator concepts, if relevant to design
1: Reservations	• Definitions are clear, but not clearly linked to existing theory/literature • Definitions are linked to existing theory/literature but do not make an entirely clear distinction between comparator concepts • Operationalisation is potentially unclear but with some theoretical justification for this • Some risk of confusion of comparator concepts by participants, if relevant to design
0: No	• No definitions • Definitions are broad and unfocused, or strongly at odds with existing theory/literature • No links to theory and literature • No appropriate justification for unclear definitions • No attempt to operationalise, or operationalisation is too unclear to distinguish between variables, with no theoretical justification for this

Notes

3. Participants are well-described and appropriate for study question & design	**Score:**
2: Yes	• Baseline characteristics are described and quantified (e.g. age, sex, cohort) • Inclusion/exclusion criteria are clear and justified • Sample is likely to provide a good representation of the populations
1: Reservations	• Description of baseline characteristics is flawed (e.g., means but no SD) • Selection process is unclear (e.g., no inclusion criteria)or flawed (e.g., inclusion/exclusion criteria seem inappropriate and are not justified) • Acknowledged limitations in selection of participants
0: No	• Baseline characteristics not described, or only in very broad terms • Not possible to determine who/what the sample consists of • Sample range so restricted that it severely limits conclusions
Notes	

4. Sample size is appropriate	**Score:**
2: Yes	• Sufficient size to draw conclusions related to study question • Justification for sample size (e.g. power calculation; comparison with previous literature) • In line with norms for the methodology • Enough participants in each group to identify differences in the outcome
1: Reservations	• Sample size appears small for norms for methodology • No justification for sample size • Acknowledged limitation of sample size
0: No	• Sample size not known • Clearly underpowered for research question • Far outside of norms for methodology
Notes	

5. Grouping/allocation of participants is well-described and appropriate	**Score:**
2: Yes	• Allocation of participants to groups is clearly described and appropriate to the design (e.g., randomisation) • Control/comparator group is appropriate • Groups are sufficiently similar on key factors that could affect the outcome, or differences are adjusted for and/or taken into consideration when interpreting the findings • Groups are of roughly equal sizes
1: Reservations	• Indications that randomisation may not have been carried out appropriately • Control/comparator group exists but is not ideal

	• Groups appear to differ on key factors that could affect the outcome, and this is not adjusted for or taken into consideration in interpreting the findings • Markedly unequal group sizes • Acknowledged limitations in grouping
0: No	• No evidence of appropriate allocation to groups, or unclear how this was achieved • No control/comparator group where one is needed • Groups differ seriously on key factors that could affect the outcome • Not possible to tell whether groups differ
2: N/A	• Groups not relevant to research design (e.g. within subjects)
Notes	

6. Methodology is clearly described and appropriate	**Score:**
2: Yes	• Justification is given for choice of methods • Enables study questions to be answered / hypotheses to be tested • Methods are applied appropriately (e.g., administration of questionnaires, treatment of experimental groups) • Methods is described in sufficient detail to enable replication
1: Reservations	• Unclear why a specific methodology was chosen, but seems broadly appropriate • Some limitations on how well study questions can be answered / hypotheses can be tested • Some minor methodological flaws (e.g., failure to control for some confounding variables, but addressed in interpretation) • Description gives overview of methods, but would be hard to replicate fully • Acknowledged limitations in methodology
0: No	• Unclear what methodology was used and why • Does not enable study questions to be answered / hypotheses to be tested • Clear departure from norms for applying the methods, or cannot be determined from unclear write up
Notes	

7. Measurements are well-described and appropriately taken	**Score:**
2: Yes	• Description makes it clear what is being measured and how it relates to the study questions/hypotheses • Dara collection tools are a good match for the concepts being studied • Data collection tools are shown to be valid and reliable • Measurement of key variables is sufficiently precise to enable appropriate analyses and conclusions • Potential sources of measurement error are identified and mitigated where possible

1: Reservations	• Link between measurement approach and study questions/hypotheses not completely clear • Data collection tools relevant to concepts being studied, but some mismatch • Data collection tools have some limitations in validity or reliability • Limited attempts to identify and mitigate potential sources of measurement error • Acknowledged limitations in approaches to measurement
0: No	• Unclear what is being measured and why • Data collection tools clearly not suited to concepts being studied • Data collection tools are clearly not valid or reliable, or it is not possible to tell • Serious measurement errors evident
Notes	

8. Data analysis methods are well-described and appropriate	**Score:**
2: Yes	• It is clear how the data were analysed and why • Analysis methods are appropriate for the methodology and study questions/hypotheses • Data were prepared handled appropriately (e.g., missing data, transformations, transcriptions)
1: Reservations	• The reasons for the choice of analysis are unclear • Analysis methods do enable study questions/hypotheses to be addressed but there are clearly more appropriate methods available • Lack of clarity about how data were prepared and handled
0: No	• Data analysis was not described • Data analysis was clearly incorrect • Data analysis is clearly unsuited to the methodology and study questions/hypotheses
Notes	

9. Main results are clearly reported	**Score:**
2: Yes	• Statistics and other quantitative findings are clearly reported in line with accepted norms (e.g., mean scores with measures of variance) • Themes or other qualitative findings are well organised and clearly described in line with norms for the methodology chosen
1: Reservations	• Statistics and other quantitative findings are sparsely reported (e.g., mean scores but no measures or variance) • Themes or other qualitative findings are broadly understandable but it is unclear why they are presented that way, or they deviate somewhat from accepted norms
0: No	• It is not clear what was found • Statistics are minimally reported or absent

	• Qualitative findings are disorganised with no clear rationale for how they are presented
Notes	

10. Conclusions are supported by the results	**Score:**
2: Yes	• Explicit links are made between results and conclusions • Conclusions are justifiable, and not extended unreasonably beyond the results • Findings that do not follow the general pattern of results, or are not entirely consistent with the main conclusions of the study, are acknowledged and integrated into the conclusions
1: Reservations	• Conclusions are clearly related to the results, but are over-extended • Inconsistent findings are only briefly acknowledged or glossed over
0: No	• Conclusions are clearly at odds with the results • Conclusions are extended far beyond what can reasonably be supported • Inconsistent findings are not acknowledged
Notes	

Developed by

Lucy Mackintosh, King's College London
May 2015

Sources

Effective Public Health Practice Project. (1998). *Quality Assessment Tool for Quantitative Studies*. Hamilton, Canada: Author. Retrieved from http://www.ephpp.ca/PDF/Quality%20Assessment%20Tool_2010_2.pdf

i-HOP. (2015). *i-HOP's Quality Assessment Tool for research and evidence around Children of Offenders*. Ilford, England: Author. Retrieved from https://www.i-hop.org.uk/app/answers/detail/a_id/726

Public Health Wales Observatory. (2014). *Questions to assist with the critical appraisal of a cross-sectional study (Type IV evidence)*. Carmarthen, Wales: Author. Retrieved from www2.nphs.wales.nhs.uk

Rosella, L., Bowman, C., Pach, B., Morgan, S., Fitzpatrick, T., & Goel, V. (2016). The development and validation of a meta-tool for quality appraisal of public health evidence: Meta Quality Appraisal Tool (MetaQAT). *Public Health*, *136*, 57–65. https://doi.org/10.1016/j.puhe.2015.10.027

Specialist Unit for Review Evidence (SURE). (2013). *Questions to assist with the critical appraisal of randomised controlled trials and other experimental studies*. Cardiff, Wales: Author. Retrieved from http://www.cardiff.ac.uk/insrv/libraries/sure/doc/SURE_RCT_Checklist_2013.pdf

Empirical Research Project

Does recruiting attentional control in the presence of threat reduce worry?

Supervisors: Dr Colette Hirsch, Dr Charlotte Krahé

Table of contents

List of tables

List of figures

Abstract

Background and aims: Worry is associated with deficits in attentional control that are thought to contribute to its persistence. Training to improve attentional control could therefore lead to a reduction in worry. The study aimed to employ a training procedure (previously used to reduce rumination) to reduce worry, and to test two competing theories regarding the mechanism of change: 1) that training improves attentional control (specifically, the ability to inhibit threatening material), resulting in a greater ability to stop worrying; or 2) that attentional resources are briefly depleted during training, reducing the processing of threatening stimuli and limiting their effect on mood, resulting in lower levels of worry

Method: Sixty-nine participants were randomly assigned to a training or a control group. Both groups completed a training procedure consisting of flanker trials (congruent and incongruent), passively-viewed pictures and a colour discrimination task. For the training group, the incongruent flankers, which recruit attentional control, primarily preceded threatening pictures. For the control group, incongruent flankers primarily preceded neutral pictures. In a worry transfer task, participants worried for a period before attempting to stop. Additional tasks assessed attentional control and tested predictions arising from the competing theories.

Results: There was no difference between groups in ability to stop worrying. No clear group differences emerged during training, and there were no group differences in attentional control following training. The control group showed a greater reduction in positive mood following training, but there were no group differences in negative mood change. Mood emerged as a partial predictor of the ability to stop worrying.

Conclusions: Contrary to predictions, the training procedure did not lead to a reduction in worry. There was no good evidence to support the theory that training improved attentional control. There was some very limited support for the theory that the training group showed reduced processing of threat pictures during training. Reasons for the findings, including the possibility that the materials were not well-suited to the task, are discussed.

1. Introduction

Worry is a cognitive process characterised by poorly controlled, negative thoughts about an uncertain future outcome (Borkovec, Robinson, Pruzinsky, & DePree, 1983). Excessive worry, which is central to generalised anxiety disorder (GAD; American Psychiatric Association, 2013), is associated with a range of negative outcomes (Llera & Newman, 2010; Szabó, 2011). Although it is typically experienced as aversive, it can nevertheless be highly persistent (Ruscio et al., 2005).

It has been suggested that the persistence of worry may be linked to underlying maintaining cognitive processes (Hirsch, Hayes, & Mathews, 2009). In particular, theoretical models of persistent anxiety (Eysenck, Derakshan, Santos, & Calvo, 2007) and worry (Hirsch & Mathews, 2012) give a central role to deficits in attentional control. Attentional control involves a number of key processes (Miyake et al., 2000), two of which may be of particular relevance to worry (Eysenck & Derakshan, 2011): an inhibiting process whereby irrelevant stimuli or responses are prevented from disrupting the task at hand, and a shifting process, whereby attentional focus is moved to different task-relevant stimuli as needed. Experimental evidence shows that worry disrupts attentional control in people with high levels of habitual worry (Hayes, Hirsch, & Mathews, 2008) and in people with GAD (Stefanopoulou, Hirsch, Hayes, Adlam, & Coker, 2014). Furthermore, people who report higher levels of worry demonstrate poorer attentional control in the face of threatening distractors, while poorer attentional control is associated with more intrusive worry thoughts (Fox, Dutton, Yates, Georgiou, & Mouchlianitis, 2015). People who worry excessively thus have a relatively impaired ability to employ attentional control strategies in the face of threat, and this deficit is presumed to contribute to intrusive worry.

Attentional control can be improved using training tasks that require repeated attentional shifting or inhibition (Cepeda, Kramer, & Gonzalez de Sather, 2001; Kramer, Larish, & Strayer, 1995), and there is some evidence that this can lead to improvements in the ability to control repetitive negative thinking. Two studies have demonstrated an effect on rumination, a form of poorly controlled negative thinking with many similarities to worry (Ehring & Watkins, 2008; Fresco, Frankel, Mennin, Turk, & Heimberg, 2002): Cohen, Mor, and Henik (2015) used inhibitory training to reduce rumination, while Siegle et al. (2014) demonstrated that adding attentional

control training to treatments for depression led to greater decreases in in rumination. However, the evidence that attentional control training can reduce worry is more limited. Fox et al. (2015) trained participants using an inhibitory training task, but they did not worry significantly less than controls in a subsequent worry transfer task.

Fox et al.'s (2015) study employed emotionally neutral materials in the training procedure. Given that worry is particularly associated with deficits in the ability to control attention to threat, it is possible that training with threat-related materials would be more effective. Cohen et al.'s (2015) inhibitory training procedure to reduce rumination took this approach, using sad emotional stimuli (rumination being particularly associated with dysphoria; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). The inhibitory training was achieved by use of a flanker task, which requires participants to identify a target stimulus flanked by distractor stimuli (Eriksen & Eriksen, 1974). Flanker stimuli may be congruent (distractors are the same as the target) or incongruent (distractors differ from the target); responding correctly to incongruent flankers requires greater attentional control to inhibit the conflicting information. In Cohen et al.'s training, flankers preceded either a negative or a neutral picture, followed by a colour discrimination task. The training group and control group were both exposed to the same number of negative and neutral pictures, and the same number of incongruent and congruent flankers. However, in the training condition, incongruent flanker trials frequently preceded negative pictures. Over the course of training, the training group showed a significant decrease in the time taken to make colour discrimination decisions following negative pictures, while the control group did not. Cohen et al. interpret this as evidence for increased attentional control in the training group, leading to a greater ability to inhibit negative information, so that the negative pictures did not slow down the subsequent colour discrimination tasks as much. In a subsequent rumination transfer task, the training group reported less rumination than controls.

Potentially, this training paradigm could be adapted to use threat materials to improve control over worry. However, there is some reason to doubt Cohen et al.'s (2015) assertion that attentional control is being trained. In their paradigm, the flanker decision is made before the presentation of the picture – that is, attentional control is recruited *prior* to exposure to the negative stimulus. It is not clear how this

would result in recruitment of attentional control following the onset of a naturally occurring negative stimulus, which would be necessary if attentional control is to be used to inhibit a response to such a stimulus. A possible alternative explanation is that the depletion of attentional resources resulting from an incongruent flanker task leads to reduced processing of the stimulus that immediately follows it. This would mean that the training group had processed the negative pictures less than the control group, as they had more incongruent flankers preceding the negative pictures. This could lead to a relatively poorer mood in the control group, which in turn could give rise to group differences in the rumination transfer task. Cohen et al. reported no group differences in mood changes after training, but do report further analyses that show some interaction of training condition and mood on rumination, which suggests there may have been some more subtle effects on mood. Furthermore, their rumination transfer task consisted of a period of remembering an upsetting event, followed by a period of sitting quietly, then completing a questionnaire reporting levels of rumination in that moment. It is arguably more a test of the tendency to ruminate when given the opportunity to dwell on unpleasant events, than a test of the ability to deliberately exert control to stop rumination, and hence not an ideal test of improvement in attentional control.

The distinction between these explanations of Cohen et al.'s (2015) findings is important. A training procedure that improves the ability to inhibit negative material and thereby reduce repetitive negative thinking could be of some clinical significance, offering the possibility of new interventions to reduce distressing and potentially harmful worry in people with anxiety disorders. A procedure that temporarily limits processing of threatening materials, on the other hand, would not be clinically valuable. Distinguishing between these competing theories is therefore of some consequence.

1.1. Current study

The current study aimed to determine whether Cohen et al.'s (2015) training paradigm can be employed to reduce worry, and to test two competing theories of the mechanism of change: 1) that training improves attentional control (specifically, the ability to inhibit threatening material), resulting in a greater ability to stop worrying; or 2) that attentional resources are briefly depleted during training,

reducing the processing of threatening stimuli and limiting their effect on mood, resulting in lower levels of worry.

Participants, allocated to either a training group or a control group, completed blocks of trials consisting of a flanker, a picture and a colour discrimination decision. All participants were presented with 50% incongruent flankers and 50% congruent, and with 50% threat pictures and 50% neutral. In the training condition, the incongruent flankers were predominantly followed by threat pictures. In the control condition, the incongruent flankers were predominantly followed by neutral pictures. Control over worry was assessed by a task in which participants worried, then attempted to stop. Mood was assessed before and after training. Two novel tasks were introduced to test mechanisms of change. An attentional control transfer task (similar to the training task) tested whether attentional control was improved as a result of training: threat and neutral pictures were presented *before* the flankers, to see how much threat pictures slowed down responses to flankers. A forced choice recognition task was also added, in which participants were shown pictures used in the preceding tasks, interspersed with distractor items, and asked whether they had seen them before; this was intended to test whether the groups had processed the pictures to different extents during training.

1.1.1. Hypothesis concerning reduction in worry

It was hypothesised that the training group would report fewer negative thoughts in the worry transfer task than the control group.

1.1.2. Hypotheses concerning mechanisms of change

1.1.2.1. If training improves attentional control

The following additional hypotheses can be made if threat training results in improved attentional control to inhibit threat stimuli:

In the training task, there will be an interaction between training block (i.e., the first and last blocks of trials) and training condition for colour discrimination speeds following negative pictures (negative pictures are expected to slow down the colour discrimination decisions that immediately follow them; both groups are expected to

get faster by the last block of trials due to practice effects; but the training group are expected to improve more as their attentional control improves)

In the attentional control transfer task, the training group will show less emotional interference than the control group (where emotional interference is the difference between flanker response speeds following threat and neutral pictures: the more that threat pictures slow flanker decision speeds, the greater the emotional interference; if attentional control is better, there should be less emotional interference)

1.1.2.2. If training involves reduced processing of threat pictures

The following additional predictions can be made if training involves reduced processing of threat pictures (and, similarly, if the control condition involves reduced processing of neutral pictures, as these primarily follow incongruent flankers for this group):

- In the training task, the training group will have faster speeds on colour discrimination decisions after threat pictures than the control group, across all trials of the training task (because they are processing the threat pictures less thorough the task)
- Following the training, the control group will show greater increases in negative mood and greater reductions in positive mood than the training group (as they will have processed the threat pictures more)
- Post-training mood will predict performance on the worry transfer task (as this is the main mechanism by which differences in worry arise)
- The training group will perform less well in recognising threat pictures (as they will have processed them less), while the control group will perform less well at recognising neutral pictures[1] (as they will have processed them less)

1 Taking into account the likelihood that threat pictures would in general be recognised more readily than neutral one because of their more intense valence and arousal (Kensinger, 2011)

2. Methods

2.1. Design

The design was a between-subjects experimental design, in which participants were randomly allocated to either a training group or a control group. The training task involved completing blocks of trials consisting of a flanker decision, a passively-viewed picture, and a colour discrimination decision. Both conditions involved equal numbers of congruent and incongruent flankers and threat and neutral pictures, but in the training condition incongruent flankers were primarily followed by threat pictures, while in the control condition incongruent flankers were primarily followed by neutral pictures.

The effectiveness of training in reducing worry was assessed by a worry transfer task in which, after a period of induced worry, participants attempted to stop worrying while reporting intermittently on the valence of their thoughts (negative or not negative). The independent variable was training group (two levels: training and control). The dependent variables were the proportion of non-negative thoughts and the longest run of non-negative thoughts.

Additional tasks and analyses were included to test hypotheses concerning the mechanisms of any changes resulting from the experimental manipulation.

2.2. Ethical considerations

Ethical approval for the study was granted by the King's College London Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (see Appendix 1). As participants were exposed to potentially upsetting materials and required to worry, they were given an opportunity to raise concerns and were provided with details of sources of support.

2.3. Sample size calculation

The required sample size calculation was based on detecting a difference between the groups in the worry transfer task. As this is a novel task, no previous effect sizes are available, but the rumination transfer task used by Cohen et al. (2015) yielded a

medium effect size, $d = 0.54$. The a priori calculation was therefore based on finding a medium effect size in a multiple regression with five predictor variables. The calculation, set at $\alpha = 0.05$, power = 0.8, $f^2 = .20$, indicated that a sample size of 65 was required.

2.4. Participants

Seventy participants were recruited from staff and students at King's College London and from the wider community, who responded to an advertisement for participants for a study into information, attention and worry. Participants were aged 18 or over, native or fluent English speakers, with normal vision (corrected if necessary) and normal colour vision. Data for one participant from the neutral training condition were removed due to equipment failure, leaving 34 participants in the neutral training condition and 35 in the threat training condition. Participant characterises are given in See Table 1.

Table 1

Participant characteristics by group

Measure	Group		Possible scores
	Training	Control	
Age (years)	25.29 (7.33)	23.32 (3.35)	–
Female:Male	29:6	29:5	–
PSWQ	50.83 (15.74)	55.97 (8.07)	16 – 80
DASS21: Depression	10.23 (10.25)	9.71 (9.32)	0 – 42
DASS21: Anxiety	7.89 (8.61)	7.47 (8.40)	0 – 42
DASS21: Stress	13.26 (10.11)	14.12 (10.82)	0 – 42
Initial positive mood	62.24 (19.48)	61.82 (15.88)	0 – 100
Initial negative mood	25.77 (19.71)	26.49 (18.11)	0 – 100

Note: Standard deviations in parentheses. PSWQ = Penn State Worry Questionnaire. DASS21 = Depression, Anxiety and Stress Scale short form. Positive and negative mood scores from a task designed for this study

The groups did not differ significantly in age, $t(67) = -1.42$, $p = .16$. They did not differ significantly in scores on the Penn State Worry Questionnaire (Meyer, Miller, Metzger, & Borkovec, 1990), $t(67) = 1.70$, $p = .09$, and both groups were just at or below the cut off of 56 for high anxiety (Molina & Borkovec, 1994). They did not differ significantly in scores on the Depression, Anxiety and Stress Scale short form (Lovibond & Lovibond, 1995) subscales of depression, $t(67) = -0.22$, $p = .83$, anxiety, $t(67) = -0.20$, $p = .84$, or stress, $t(67) = 0.34$, $p = .73$; mean scores for depression were just in the mild range (10-13) for the training group and in the normal range for the control group; means scores for anxiety for both groups were just below the mild range (8-9); and means scores for stress were just below the mild range (15-18) for both groups. The groups did not differ significantly on initial positive mood, $t(67) = -0.10$, $p = .92$, or initial negative mood, $t(67) = 0.16$, $p = .88$.

2.5. Training task

The training task consisted of 384 trials, each comprising a fixation cross, a flanker stimulus and response, a passively viewed picture stimulus, and a colour discrimination stimulus and response. The trials were presented in eight blocks of 48 trials each, with a break of at least 15 seconds in between blocks (during which no response could be made on the computer). A sample trial is shown in Figure 1.

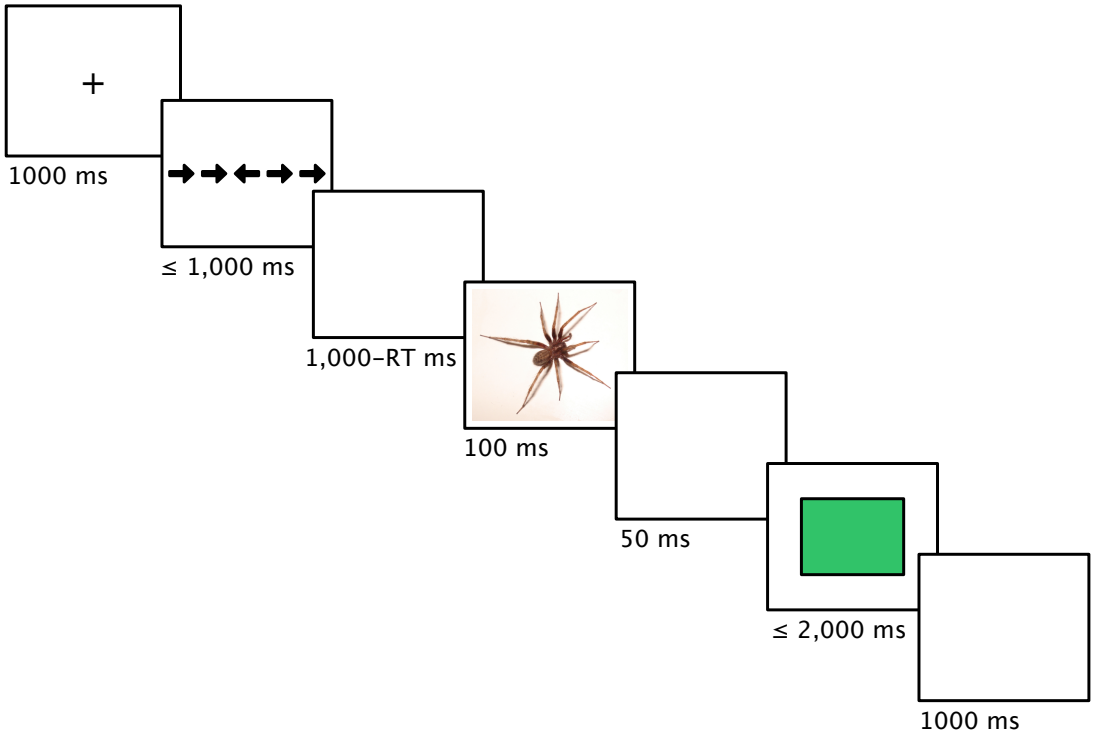


Figure 1. Example of a training trial in which an incongruent flanker stimulus precedes a threat stimulus

Following Cohen et al.'s (Cohen et al., 2015) paradigm, participants were instructed to look at a fixation cross in the centre of a screen, which remained for 1,000 ms. The flanker stimulus consisted of a row of five arrows, with participants being instructed to press a key as quickly and accurately as possible to indicate the direction in which the central arrow was pointing. 50% of trials included a congruent flanker stimulus, in which all arrows pointed in the same direction (e.g., →→→→→), and 50% were incongruent, in the which the central arrow pointed in the opposite direction from the flanking arrows (e.g, →→←→→). All four possible combinations of left–right congruent–incongruent sets of arrows were used, in random order. The flanker stimulus remained on the screen for up to 1,000 ms or until the participant pressed a key with the left middle finger for a left pointing central arrow, or the right middle finger for a right pointing central arrow. Another blank screen was presented, for 1,000 ms minus the reaction time (RT) for the flanker key press. The picture stimulus, which remained for 100 ms, was of threat valence in 50% of trials and neutral valence in 50%. This was followed by a blank screen for 50 ms. The colour discrimination stimulus was either a blue or a green rectangle in the centre of the screen (50% of trials with each colour, in random order). Participants were asked to

indicate the colour of the rectangle by key press with their index finger, as quickly and accurately as possible (allocation of left and right key presses to colour were counter-balanced across groups). A inter-trial interval (ITI) of 1,000 ms of blank screen concluded each trial. Picture stimuli consisted of 24 of threat pictures and 24 neutral pictures, presented in random order. Prior to the task, participants completed eight practice trials, during which feedback was given on incorrect responses, and participants prompted to press the correct key; if no response was given in the time the stimulus was on screen, it was re-presented until the correct response was made.

2.5.1. Training conditions

All participants were presented with equal numbers of congruent and incongruent flankers and threat and neutral pictures. However, for the training group, 83.3% (160/192) of the incongruent flankers were followed by a threat picture, and the same proportion of congruent flankers were followed by neutral pictures. For the control group, the proportions were reversed. This ensured that the training group were primarily required to recruit attentional control prior to the presentation of threat stimuli.

2.5.2. Outcome measure

Performance on the flankers and colour discriminations was measured in reaction speed: the reciprocal of the reaction times once converted from milliseconds to seconds (1/RT). This is an accepted approach to transforming RT data, which is typically highly positively skewed (Whelan, 2010).[2] Mean reciprocal scores were calculated for each participant in each condition of interest (which varied for the different analyses).

2.6. Worry transfer task

The worry transfer task tested the effects of training on the ability to stop worrying. Participants were first asked to identify a worry topic that was currently particularly

2 Preliminary analyses confirmed that the RT was highly skewed, leading to violations of the assumptions of linear regression, in particular marked heteroscedasticity. Trimming the data by removing outliers did not markedly improve the distributions. After any initial exclusion of data, all RT scores were therefore transformed into reciprocal speed scores.

negative for them. They were asked a series of questions about the negative aspects of the topic to facilitate worry. They were then taken through the instructions, and left alone for the remainder of the task. They were required to worry in their usual way about the topic for 1 minute, after which a beep sounded on the computer, at which point they were to stop worrying. The beep sounded every 10 s thereafter, and the word "Thought?" was presented on the screen, prompting participants to indicate the valence of their thoughts (*negative* or *not negative*) by keypress. This was repeated for 30 trials over 5 minutes.

2.6.1. Outcome measures

Two outcome measures were used for the worry transfer task: the proportion of trials rated as not negative, excluding missing trials (a proxy for the the extent to which a participant was able to avoid and/or stop negative thoughts), and the longest run of trials rated as not negative (a proxy for the ability to sustain the inhibition of negative thoughts). Higher scores on both measures would indicate greater attentional control.

2.7. Attentional control transfer task

The attentional control transfer task was completed twice. It was administered before training to give a baseline measure, then repeated after the training task to examine whether training led to a reduction in the negative impact of threat stimuli on decision speeds. The task consisted of 48 trials that were very similar to the training task, but with the contents reordered so that the picture stimulus came before the flanker stimulus, thus consisting of: 1,000 ms fixation cross; 100 ms picture stimulus; 50 ms blank screen; up to 1,000 ms flanker stimulus and response; 1,000 ms minus flanker RT blank screen; up to 2,000 ms colour discrimination stimulus and response; 1,000 ms blank screen ITI. As the baseline task was the first time participants were introduced to the process, a detailed practice was provided: eight practice trials of the colour discrimination task, eight trials of flanker and colour discrimination tasks, and eight full trials. They completed a further four full practice trials prior to the post-training task. Feedback and corrections were as for the training task.

2.7.1. Outcome measure

Flanker decision performance was measured as the response speed (1/RT). Additionally, a measure of emotional interference was calculated: the difference between flanker response speeds following neutral pictures, and flanker response speeds following threat pictures. Colour discrimination performance was not analysed; the colour discrimination judgment was included in the task to preserve similarity between the tasks and to minimise carry-over effects between trials.

2.8. Recognition test

The recognition test examined whether the groups differed in their ability to recognise pictures from the training task. Participants were presented with the pictures, interspersed with distractor pictures (all in random order), and asked to indicate whether or not they thought they had previously seen the pictures and to rate their confidence in their response. A fixation cross was presented for 1,000 ms, followed by a picture for up to 1,000 ms; participants were instructed to respond quickly. They indicated whether they had seen the picture by pressing keys for *yes* or *no* (counterbalanced across groups between left and right index finger). They were then presented with the question "How sure are you about that?" and a visual analogue scale (VAS) consisting of a line with 100 tick marks, with a longer central tick mark and end marks, labelled *Not at all sure* at the far left and *Very sure* at the far right. They used the mouse to click on the appropriate point on the line. Stimuli were the 24 pictures used only in the training task and 24 distractor items, each one matched with a training picture for visual similarity.

Before starting the task, participants learnt the yes and no keys by responding to the words "Yes" and "No", presented for 10 trials in random order. Incorrect responses received an instruction to press the correct key. They then completed four practice trials. For the practice trials only, they were given feedback on how they had answered, in the form of "You said yes/no, you have/haven't seen that before".

2.8.1. Outcome measures

Two measures of recognition were calculated: accuracy and confidence. Accuracy was measured by calculating *d'* scores, a sensitivity measure calculated by subtracting

the *z* score of false alarms (distractor pictures incorrectly identified as having been seen before) from the *z* score of the hit rate (correct identification of training task pictures). Confidence ratings were calculated from the mean VAS conscience ratings for each participant for threat and neutral pictures.

2.9. Materials

2.9.1. Picture stimuli

All picture stimuli used in the training task, attentional control transfer task and recognition task were taken from the International Affective Picture Scale (IAPS; Lang, Bradley, & Cuthbert, 2008), a set of pictures with normative rating scores for valence from 0–9 (least to most happy) and for arousal from 0–9 (least to most arousing). In total, 120 pictures were selected, with 60 representing threat and 60 being neutral. Threat pictures were selected to have low valence (M = 2.98, SD = 0.59) and moderate to high arousal (M = 5.71, SD = 0.84). Neutral pictures were selected to have medium valence (M = 5.49, SD = 0.59) and low arousal (M = 3.36, SD = 0.48). Of the subset of threat pictures used in the training task, valence (*M* = 2.96, *SD* = 0.65) and arousal (*M* = 5.67, *SD* = 0.90) were similar to that of the total threat pictures; the same was true for the valence (*M* = 5.5, *SD* = 0.69) and arousal (*M* = 3.40, *SD* = 0.44) of the neutral training pictures. See Appendix 2 for full details of pictures and comparisons.

2.9.2. Emotional assessment measures

2.9.2.1. Penn State Worry Questionnaire (PSWQ)

Trait worry was assessed using the PSWQ (Meyer et al., 1990), a 16-item self-report measure of tendency to worry (see Appendix 3). Each items is a statement about worry, scored on a 5-point Likert scale from 1 (*Not at all typical of me*) to 5 (*Very typical of me*). These are summed (with positive items reversed scored) to yield a single trait worry score between 16 and 80. The scale has good psychometric properties in clinical and non-clinical populations (Brown, Antony, & Barlow, 1992; Molina & Borkovec, 1994). Cronbach's alpha reliability in this sample was .93.

2.9.2.2. Depression, Anxiety and Stress Scale short form (DASS21)

The DASS21 is a 21-item self-report measure of depression, anxiety and stress in the present and recent past, based on an original 42-item measure (Lovibond & Lovibond, 1995). It consists of three subscales with seven items in each, rated on the extent to which each item has applied over the past week, on a 4-point scale from 0 (*Did not apply to me at all*) to 3 (*Applied to me very much, or most of the time*). Scores for each item are doubled (to enable comparison with the full 42 item scale) and summed to give three subscale scores from 0–42 each. It has satisfactory psychometric properties in clinical and non-clinical populations (Antony, Bieling, Cox, Enns, & Swinson, 1998). Cronbach's alpha reliabilities in this sample were .89 for depression, .85 for anxiety and .90 for stress.

2.9.2.3. Mood ratings

A 14 item visual analogue mood rating scale was created using items from the Positive and Negative Affect Schedule – Expanded Form ([PANAS-X]; Watson & Clark, 1999), with two 7 item subscales, one consisting of positive affect items and one of negative affects items (see Appendix 5). The visual analogue scale consisted of a line with 100 tick marks; the left end was labelled *highly disagree* (and scored 0) and the right end was labelled *highly agree* (and scored 100). Scoring was completed by clicking on the scale with the mouse. Participants were presented with the statement "Currently, I feel" with one of the items, presented in random order, and instructed to rate how they felt at that moment. Prior to the first use of the scale, they completed two practice items.

Positive and negative mood scores for each time point were created for each participant from the mean scores of each subscale, and a difference score was calculated by subtracting the post-training score from the pre-training score. Cronbach's alpha was .90 for the pre-training negative items, .91 for the pre-training positive items, .90 for the post-training negative items, and .94 for the post-training positive items.

2.9.3. Filler task

A filler task was completed after the training and after the booster training order to neutralise mood effects of training and to reduce the effects of fatigue on computer tasks. Adapted from the Speed of Comprehension Test (Baddeley, Emslie, & Nimmo-Smith, 1992), it consisted of a set of statements with a checkbox next to each statement; participants indicated whether a statement was true or false by putting a tick or cross on the box. Participants were instructed to work at their own pace with no pressure to complete all items. Two separate versions were used, each with 100 statements and a time limit of two minutes. See Appendix 8 for details.

2.10. Procedure

One day prior to the session, participants were emailed a link to the pre-session questionnaires (demographic questions, PSWQ and DASS21) to complete before attending. On arrival, they were given an overview of the session, with the opportunity to ask questions, and invited to sign an informed consent form (see Appendix 3). All tasks except the filler task were presented on a standard 15" laptop using ePrime software. Participants completed the mood ratings, the baseline attentional control transfer task, and the training task (during which the experimenter left the room). The filler task was then administered, followed by the attentional control transfer task, the recognition task, 24 booster training trials, and the second version of the filler task. The experimenter then induced worry, explained the worry transfer task, and left the room for the duration of the task. In order to check for demand effects, participants were asked, "Do you have any thoughts or ideas as to what the study was about?"; following a debriefing, they were asked, "So is that what you thought the study was about?" (due to experimenter error, this check was only introduced approximately halfway through the study). Participants were given the opportunity to ask questions, before being given £15 to compensate for their time and expenses. Sessions lasted for approximately 1.5 hours. An overview of the key session tasks is shown in Figure 2.

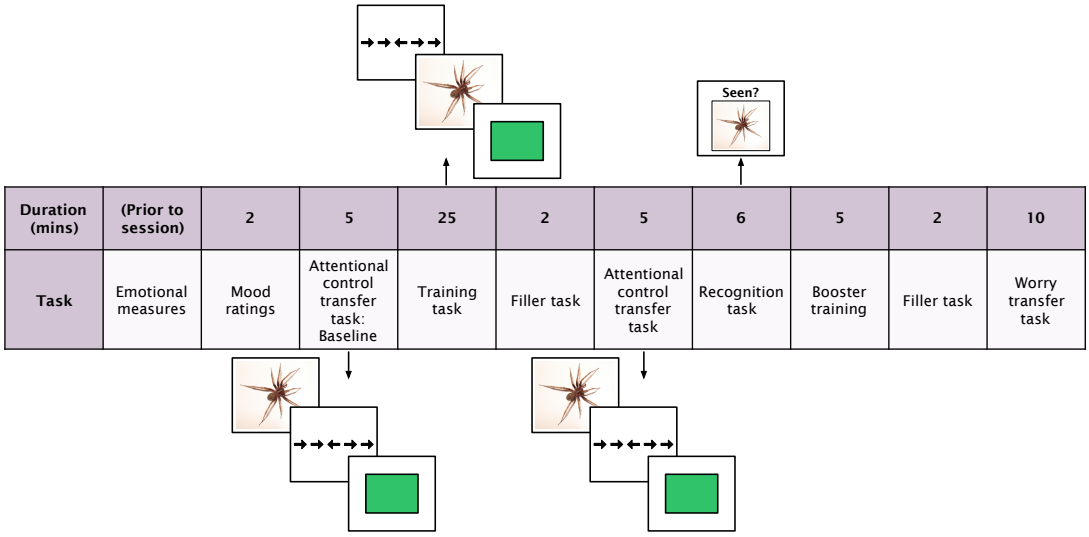


Figure 2. Overview of the key session tasks

2.11. Data analysis plan

In several of the analyses (training task, attentional control transfer task, recognition task), the repeated measures (flanker congruence, picture valence, training block) were nested within participants. In these cases, the analyses were completed using multilevel linear modelling, with the repeated measures at Level 1 and the participants at level 2. Where appropriate, PSWQ scores were included as a random effect. Continuous variables were centred around grand means to reduce the potential influence of multicollinearity (Tabachnick & Fidell, 2005). Additional analyses for the training task were carried out using paired t tests and simple linear regression. The worry transfer task, and one analysis within the attentional control transfer task, did not contain nested data, and were therefore analysed using multiple regression. Differences in pre- and post-training mood scores between the training and control groups were compared using independent t tests.

Main effect sizes using Cohen's *d* were calculated from the estimated marginal means for multilevel linear modelling analyses, and from actual means for t tests. Cohen's f^2 was calculated for multiple regressions. All post-analysis data were examined for potential violations of the assumptions of regression analyses, including non-linearity, non-normality of residuals, heteroscedasticity and multicollinearity; any marked deviations are noted in the results.

3. Results

3.1. Data preparation

For analyses of the flanker and discrimination data, missed and inaccurate[3] trials were removed from the data. Trials with RTs below 150 ms were excluded as being unlikely to reflect genuine decision-making (Whelan, 2010). Trials with extreme colour discrimination RTs of greater than 1,500 ms were excluded. No exclusions were made for long flanker decisions as they had a maximum response time of 1,000 ms set by the experimental procedure. Two participants (one from each group) did not complete the full training task due to equipment failure; however, the number of correctly completed trials completed by these participants was within the range completed by the other participants, and their data were therefore retained. Full details of data exclusions are given in Appendix 9. In summary: One control group participant's data was excluded from training task analyses, and 10.8% of all remaining trials were excluded; data from two control group participants were excluded from the mood analysis; 2.2% of all trials were excluded from the attentional control transfer task; in the recognition task, 1.42% of all trials were excluded, and data from one training group participant were also excluded.

In the worry transfer task, preliminary analyses revealed that 4.5% trials were missing, and that these were unevenly spread across trials, with 44.9% first trials missing (41.2% of the control group and 48.6% training group). The longest run of initial missing trials was four. No data were excluded.

In the mood task, several participants had perfect hit rates and/or false positives. When this is the case, the *d'* accuracy score cannot be calculated. The data were subjected to a log linear transformation by adding 0.5 to the hit and false alarm scores, and 1.0 to the total number of familiar and new pictures rated by each participant (Stanislaw & Todorov, 1999).

3 Point-biserial correlations between accuracy and RTs in the training tasks and attentional control transfer tasks indicated that there was no evidence for a speed-accuracy trade-off

3.2. Training task

In order to facilitate comparisons with Cohen et al.'s (2015) study, the same predictions were tested (although different data analytic approaches were used in some cases). Additional analyses were also carried out.

3.2.1. Preliminary analysis: Recruitment of attentional control

To check that attentional control was being recruited by the incongruent flankers (and thus that this aspect of the task was working correctly), an analysis was carried out of flanker response speeds. As no hypotheses relevant to the study questions were being tested, the full results are given in Appendix 10. In summary, the usual effect of slower speeds for incongruent flankers was found, indicating that attentional control was being recruited as intended. As expected, no group differences were found, suggesting that the flankers recruited attentional control equally for both groups.

3.2.2. Preliminary analysis: Effects of valence and congruence on colour discrimination

In line with Cohen et al.'s (2015) analysis, the effects of flanker congruence and picture valence on colour discrimination task were examined. This matters because differences in colour discrimination speeds following threat pictures are used as an indicator of differences between the groups, but the groups also differ in the combinations of flanker congruence and pictures valence to which they were exposed. If, as Cohen et al. found, negative pictures only slow down colour discrimination speeds in congruent flanker trials, it would not be possible to make a meaningful direct comparison between groups of the effect of valence on speed. To test for this effect, a multilevel linear modelling analysis was carried out with colour discrimination speed as the dependent variable, and flanker congruence (congruent, incongruent), picture valence (threat, neutral) and their interaction as predictors. There was no significant effect of valence (b = -0.02, *SE* = 0.01, p = .11), congruence (b = -0.00, *SE* = 0.01, p = .82), or the interaction between congruence and valence (b = -0.01, *SE* = 0.02, p = .71). The interaction effect that Cohen et al. found was thus not found in this study, which meant that a direct comparison of group differences on colour discrimination speeds was possible.

3.2.2.1. Additional analyses

The results of the above analysis also suggest, unexpectedly, that colour discrimination decisions were not significantly slowed by negative pictures. Because this was not anticipated, further unplanned analyses were carried out using the IAPS valence scores of individual pictures. Full details are in Appendix 11. In summary, there was a small overall effect of valence score across all pictures, but no effect within each valence group (i.e., no effect of valence score within the set of threat pictures, nor within the set of neutral pictures). The valence of pictures thus did not affect subsequent colour discrimination speeds to the extent that was expected.

3.2.3. Testing for training of attentional control

If Cohen et al. (2015) are correct that attentional control is being trained, the training group should show a greater improvement in colour discrimination speeds following negative pictures over the course of training than the control group. Both groups are expected to get faster because of practice effects, but the training group should show a greater improvement because their attentional control is improving as the training continues, and the negative pictures should slow down their colour discrimination times less. There should thus be an interaction between training block and group for colour discrimination speeds following negative pictures.

The training was completed in eight blocks, so speeds in the first and last blocks were compared. A multilevel linear modelling analysis was carried out with colour discrimination speed as the dependent variable; training group (training, control), picture valence (neutral, threat) and training block (first, last) were entered as predictors. The results are shown in Table 2.

The only significant effect was the main effect of training block, with colour discrimination responses speeds in the last block being faster (M = 2.13, SD = 0.41) than the first (M = 1.96, SD = 0.41), d = 0.36, indicating that participants improved their speeds over time. There was no effect of group and thus, in contrast with the previous analysis, no evidence for training improving attentional control for the training group. No effect was found for valence, alone or in interaction, and thus no evidence to suggest the threat stimuli significantly interfered with colour discrimination for either group. This offers no support for the idea that the training

group showed improved attentional control as training progressed, but also (as suggested by the valence analyses described above), implies that threat pictures did not impact on colour discrimination speeds.

Table 2

Training task: Multilevel modelling results for effects of group, picture valence and training block on colour discrimination decision speeds

	Unstandardised coefficient (b)	*SE*(b)	*p* value	95% CI
Group	0.08	0.09	.36	-0.09, 0.25
Valence	-0.01	0.04	.70	-0.09, 0.06
Group x Valence	-0.05	0.05	.40	-0.15, 0.06
Block	**0.20**	**0.04**	**.00**	**0.12, 0.27**
Group x Block	-0.06	0.05	.27	-0.17, 0.05
Valence x Block	-0.04	0.05	.45	-0.15, 0.06
Group x Valence x Block	0.08	0.08	.29	-0.07, 0.23

Note: Significant results highlighted in bold.

Cohen et al. were unable to compare the groups directly in this way because, as noted above, they had found a moderating effect of flanker congruence on the impact of negative pictures on colour discrimination. They therefore carried out a paired t test for each group, comparing colour discrimination RTs for the first and second halves of the training. Although a finding of significant differences within groups is not evidence for a significant difference between them (Gelman & Stern, 2006), this analysis was also completed here to enable a direct comparison with Cohen et al.'s study. The reduction in RTs[4] was significant for the training group (M = 34.4, SD = 52.7, 95% CI [16.3, 52.5], $t(32) = 3.86$, $p = .001$, $d = 0.65$. The reduction in RTs for the control group was not significant (M = 16.7, SD = 59.6, 95% CI [-4.4, 37.9], $t(32) = 1.61$, $p = .12$, $d = .28$. This is line with Cohen et al.'s

4 RTs were used rather than speeds to maximise the similarity in analyses

findings, which they interpreted as suggesting an effect of training on attentional control.

3.2.4. Testing for reduced processing of threat stimuli

If, instead of improving attentional control, the training involves reduced processing of threat stimuli, the training group should show less impact of threat pictures on colour discrimination speeds than the control group across all trials. An independent t test was carried out with colour discrimination speeds on threat trials as the independent variable, and training condition as the dependent variable. The difference between speeds for the training group (*M* = 2.05, *SD* = 0.33, 95% CI [1.9, 2.2]) and the control group (*M* = 2.08, *SD* = 0.32 , 95% CI [2.0, 2.2]) were not significant, $t(66) = 0.39$, $p = .70$, $d = 0.10$. This offers no support for the idea that the training group paid less attention to the threat pictures and were therefore less affected by them throughout the whole task.

3.3. Mood

If training involves reduced processing of threat stimuli, the control group would be expected to evidence worse mood following training than the training group, as they will have processed the threat pictures more. Independent t tests[5] were carried out for positive and negative mood change. The control group showed a greater reduction in positive mood (*M* = -7.67, *SD* = 10.72, 95% CI [-11.5, -3.8]) than the training group (*M* = -1.57, *SD* = 9.06, 95% CI [-4.7, 1.5]); this difference was significant, $t(65) = -2.52$, $p = .01$, and represented a medium effect size, $d = -0.62$. However, the control group did not show an increase in negative mood (*M* = 2.17, *SD* = 13.1, 95% CI [-2.6, 6.9]) that was significantly greater than that of the training group (*M* = 0.31, *SD* = 13.01, 95% CI [-4.2, 4.8]), $t(65) = -0.58$, $p = .56$, $d = 0.14$. This offers partial support for the prediction of worse mood for the control group.

5 Data showed some non-significant deviations from normality; however the shapes of the distributions for the positive difference scores were different for the two groups, making use of a Mann Whitney U test also potentially unreliable.

3.4. Worry transfer task

Mean scores for the two outcome measures for the worry transfer task, the proportion of non-negative thoughts and the longest run of non-negative thoughts, for both training conditions are shown in Table 3. The correlation between these outcomes measures was $r = .72$, $p = .001$.

Table 3

Worry transfer task: Means of proportion of non-negative thoughts and longest run of non-negative thoughts for each group

Outcome measure	Group	
	Training	Control
Proportion of non-negative thoughts	0.73 (0.24)	0.69 (0.25)
Longest run of non-negative thoughts	13.71 (8.90)	12.06 (8.39)

Note: Standard deviations in parentheses

Two hierarchical multiple regressions were carried out, one with each stop worry measure as the dependent variable, each with the same predictors[6]. To test and control for an expected effect of trait worry, PSWQ scores were entered into as a continuous predictor. To test for an effect of training, group was entered into a second model. Finally, to examine whether post-training mood affected performance (as would be predicted if any effects of the training task arise from differences in emotional processing of threat stimuli, rather than from training attentional control), post-training negative and positive mood scores were entered as continuous predictors into a third model.

6 For both DVs, examination of the data suggested that a small number of observations may have exerted excessive influence on the model; the residuals for the model for proportion of non-negative thoughts also exhibited significant heteroscedasticity. The models were therefore re-run twice for each predictor, first with negative mood removed (as positive mood proved to be a better predictor), and again with negative mood and outlier observations removed. This did not greatly improve properties of the data. In both cases, the overall models remained broadly similar each time, with no major changes in power or significance of predictors. The original models were therefore retained, but must be interpreted with some caution.

The findings for the proportion of non-negative thoughts are shown in Table 4. In the first model, PSWQ scores were a significant predictor, with higher PSWQ scores predicting poorer performance, with a medium effect size, $f^2 = .18$. The second model did not add a significant change in R^2, and training condition was not a significant predictor. The third model did add a significant change; in this model, positive mood emerged as the only significant predictor in this model, $f^2 = .17$.

Table 5 sets out the findings for the longest run of non-negative thoughts. Again, PSWQ scores were a significant predictor in the first model, $f^2 = .21$. Neither the second nor third models added significantly to the fit, and no further predictors emerged.

There was therefore no support for the prediction that the training group would report fewer negative thoughts. There was some support for an effect of mood, as would be predicted if differences in processing of threat pictures during the training task leads to mood differences that in turn impact on worry.

Table 4

Worry transfer task: Hierarchical regression results for effect of group, PSWQ and post-training mood on proportion of non-negative thoughts

	Model 1				Model 2				Model 3			
	B	*SE B*	β	*p* value	*B*	*SE B*	β	*p* value	*B*	*SE* B	β	*p* value
PSWQ	**-0.01**	**0.00**	**-.39**	**.00**	**-.01**	**0.00**	**-.39**	**.00**	-0.00	0.00	-.14	.30
Group					-.00	0.06	-.00	.99	0.03	0.05	.05	.62
Negative mood									0.00	0.00	.09	.58
Positive mood									**0.01**	**0.00**	**.51**	**.01**
Constant	1.11	0.12		.00	1.11	0.12		.00	0.84	0.14		.00

Note: Step 1 $R^2 = .15$ for, $F(1, 67) = 12.03$, $p < .01$. Step 2 $\Delta R^2 = .00$, $F(1, 66) = 0.00$, $p = .99$. Step 3 $\Delta R^2 = .13$, $F(2. 64) = 5.73$, $p < .01$. PSWQ = Penn State Worry Questionnaire. Significant results highlighted in bold.

Table 5

Worry transfer task: Hierarchical regression results for effect of group, PSWQ and post-training mood on longest run of non-negative thoughts

	Model 1				Model 2				Model 3			
	B	*SE B*	β	*p* value	*B*	*SE B*	β	*p* value	*B*	*SE B*	β	*p* value
PSWQ	**-0.29**	**0.07**	**-.42**	**.00**	**-0.29**	**0.08**	**-.42**	**.00**	**-0.21**	**0.09**	**-.31**	**.03**
Group					-0.19	1.95	-.01	.92	0.22	1.97	.01	.91
Negative mood									0.00	0.08	.00	.99
Positive mood									0.09	0.08	.21	.29
Constant	28.23	4.11		.00	28.24	4.15		.00	23.85	5.11		.00

Note: Step 1 R^2 = .18 for, $F(1, 67) = 14.68$, $p < .01$. Step 2 ΔR^2 = .00, $F(1, 66) = 0.01$, $p = .92$. Step 3 ΔR^2 = .03, $F(2. 64) = 1.08$, $p = .34$. PSWQ = Penn State Worry Questionnaire. Significant results highlighted in bold.

3.5. Attentional control transfer task

3.5.1. Preliminary analysis: Effects of valence and congruence on colour discrimination

The primary outcome measure for the attentional control transfer task was emotional interference scores: that is, the difference between flanker decision speeds following neutral pictures and following threat pictures, which serves as in indicator of the extent to which threat pictures disrupt flanker speeds. It was therefore necessary first to determine whether picture valence did effect flanker speeds. Additionally, a different study by Cohen, Henik, and Moyal (2012) found that negative stimuli can disrupt tasks involving less cognitive effort (i.e., congruent but not incongruent flankers); if this turned out to true in this study, it would be necessary to control for flanker congruence in the analysis of emotional interference.

A multilevel linear modelling analysis was carried out, with flanker response speed as the dependent variable, and picture valence (threat, neutral), flanker congruence (congruent, incongruent) and the interaction between valence and congruence as predictors. A significant main effect was found for valence (b = -0.07, SE = 0.02, p = .001), with flanker decisions following neutral pictures being faster (M = 2.12, SD = 0.32) than those following threat pictures (M = 2.07, SD = 0.32), d = 0.14. The typical effect of congruence was significant (b = -0.35, SE = 0.02, p < .001), with congruent flanker decisions being faster (M = 2.26, SD = 0.32) than incongruent (M = 1.93, SD = 0.32), d = 1.03. The interaction between congruence and valence was not significant (b = 0.04, SE = 0.03, p = .13). This suggests that negative pictures did disrupt flanker decision times, and that (in contrast to the findings from Cohen et al., 2012), this effect was not limited to congruent flankers. It was therefore possible to meaningfully compare group differences in emotional interference in the main analysis, with no need to control for flanker congruence.

3.5.2. Effects of training on emotional interference

If the training results in improved attentional control, the training group should show less emotional interference, as their flanker speeds will be slowed less by threat pictures. A multiple linear regression was carried out with emotional interference as

the DV, and group (training, control) as a categorical predictor. To control for baseline performance and trait worry, emotional interference scores from the baseline attentional transfer task (completed before training) and PSWQ scores were entered as continuous predictors. Group did not emerge as a significant predictor ($\beta = .02$, $p = .88$), and neither did baseline performance ($\beta = .05$, $p = .69$) or PSWQ scores ($\beta = .06$, $p = .65$). The overall model fit was $R^2 = .01$. There was therefore no evidence to support the prediction, made by the improved attentional control theory, that the training group showed better attentional control in the transfer task.

3.6. Recognition task

Means for both training conditions of the accuracy ratings (*d'*) and the confidence ratings at each picture valence are shown in Table 6.

Table 6

Recognition task: Mean d' accuracy ratings and confidence ratings for each picture valence, by group

Picture valence	*d'* accuracy scores		Confidence scores	
	Training	Control	Training	Control
Neutral	1.45 (0.71)	1.45 (0.72)	72.92 (15.05)	71.62 (11.63)
Threat	0.98 (0.70)	1.14 (0.68)	69.92 (15.33)	72.08 (11.24)

Note: Standard deviations in parentheses.

In general, it would be expected that threat pictures would be recognised more readily than neutral pictures because of their more intense valence and arousal (Kensinger, 2011). Additionally, if training involves reduced processing of threat stimuli, the training group should perform less well in recognising threat pictures, while the control group should perform less well at recognising neutral pictures (based on the relative attention paid to each picture type during the training task).

Two multilevel linear modelling analyses were completed, one with *d'* accuracy scores as the DV, and one with confidence scores as the DV. In each case, the predictors were group (training, control), picture valence (threat, neutral), and the

interaction between group and valence. The results of both models are set out in Table 7. The only significant finding that valence was a predictor of *d'* accuracy with a medium effect size, d = 0.56; threat pictures were recognised more accurately overall. These findings suggests that the task worked as a test of recognition (as threat pictures are expected to be recognised more), but offers no support for the theory that groups processed the pictures differently during training.

Table 7

Recognition task: Multilevel modelling results for effects of group and picture valence on accuracy and confidence measures

		b	*SE(b)*	*p* value	95% CI
Group	*d'* accuracy	0.00	0.17	.99	-0.32, 0.33
	Confidence	-1.83	3.20	.57	-8.10, 4.43
Valence	*d'* accuracy	**-0.47**	**0.17**	**.01**	**-0.79, -0.14**
	Confidence	-3.00	3.15	.34	-9.17, 3.17
Group x Valence	*d'* accuracy	0.16	0.24	.49	-0.30, 0.62
	Confidence	3.39	4.52	.45	-5.47, 12.25

Note: Significant results are highlighted in bold.

3.7. Demand characteristics

Of those participants asked whether they had any idea what the study was about (approximately half of the total sample), none indicated that they had guessed the hypotheses being tested.

4. Discussion

The study had two aims. The first was to determine whether the attentional control training paradigm created by Cohen et al. (2015) could be employed to reduce worry (rather than rumination, as in the original study). The second was to test two competing theories of the mechanism of any such effects: that training improves the

ability to use attentional control to inhibit negative stimuli (as argued by Cohen et al.), or that the brief depletion of attentional resources during the training task results in reduced processing of negative pictures by the training group, such that training has more negative impact on the control group's mood.

4.1. Effect of training on worry

The results do not offer any evidence to support an effect of training on worry: the worry transfer task, in which participants tried to stop worrying after a period of induced worry, revealed no overall differences between the groups. This is in contrast to Cohen et al.'s (2015) study, which found an effect of training in a rumination transfer task. This raises a number of questions concerning possible explanations for these different findings.

4.1.1. Was the worry transfer task an appropriate test of the ability to control worry?

The worry transfer task is a novel paradigm currently under development, and while it has good face validity as a test of the ability to avoid or stop worrying thoughts, there is as yet no published literature to support this. However, trait worry as measured by the PSWQ predicted performance on the task, indicating that participants with a greater tendency worry found it harder to stop worrying. While not conclusive, this does suggest that the task can serve as a reasonable test of the ability to control worry.

4.1.2. Did the training task not affect the training and control groups differently?

Group differences in the worry transfer task would only be expected if the training task affects the training and control groups differently in some way. Two competing theories of how it might do so have been proposed here. Predictions arising from both of these were made in relation to performance on the training task, neither of which were fully borne out: the training group did not show improvements over time in colour discrimination speeds after threat pictures, compared to the control group (as it should if the training group's attentional control improves during training), and groups did not differ in colour discrimination speeds after threat pictures throughout

the task as a whole (as they should if the training groups is processing the threat pictures less). Cohen et al., in contrast, suggest that their study does show evidence for an effect within training. A number of differences between the studies that could potentially account for this difference between the two studies are considered here.

4.1.2.1. Differences in procedure

The only significant difference between the studies in procedure prior to training (which therefore could have affected training) was that participants in the present study completed a baseline version of an attentional control transfer task which was similar to the training task, albeit with the components in a different order. As both groups completed an identical task, it is unlikely it affected the groups' performance on the training task differentially. It is possible that some cognitive fatigue made the training less effective, but the baseline task was short (approximately five minutes). Furthermore, there was evidence that performance in the training task improved over time, suggesting that practice effects outweighed any fatigue effects.

4.1.2.2. Differences in materials

The current study found rather limited evidence that picture valence influenced subsequent colour discrimination speeds during the training task. If negative pictures do not markedly disrupt colour discrimination speeds, it becomes more difficult to identify an effect of training. Cohen et al. (2015) do not present data for the effect of picture valence alone, so a direct comparison with this study cannot be made, but they do report an interaction effect of flanker congruence and picture valence that was not found in the current study. It therefore appears that negative pictures in their study slowed down colour discrimination speeds in a way that they did not in the current study. It is possible that a difference in the pictures selected accounts for this: the valence of their negative pictures was slightly more negative than those used in the current study (M = 2.37 compared to M = 2.96 ; valence scale 0–9). It is therefore possible that the pictures in the current study were not negative enough to be effective in training.

However, detailed examination of the effect of valence scores of individual pictures in the current study reveals a surprisingly weak relationship between valence and effect on colour discrimination speeds. This may arise from differences in the way in which

the IAPS pictures were originally rated and the way in which they are used in this study. The valence ratings were made after viewing images for 6 s (Lang et al., 2008), while in the current study they were viewed for 100 ms, and it seems plausible that perception of threat may be quite different at these speeds. While it therefore remains possible that negative pictures in this study were less effective than those used by Cohen et al., a simple comparison of mean valences is unlikely to be a good measure of whether this is the case.

4.1.2.3. Differences in data analysis

Cohen et al. (2015) reported that they had demonstrated training effectiveness by finding that the training group showed a significant improvement on colour discrimination decision times after negative pictures over the course of the training (by comparing performance on the first and second halves), while their control group had not. The same effect was found using the same analysis in the current study, and could be taken to indicate that the training was effective. However, this is a less than ideal way of demonstrating effectiveness, as a finding of significant differences within groups is not evidence for a significant difference between them (Gelman & Stern, 2006).

Cohen et al. used this approach because they found a moderating effect of flanker congruence on the emotional interference caused by negative stimuli; the different contingencies for flanker congruence and picture valence between the groups would have confounded a direct comparison. Because that moderating effect was not found here, it was possible to also conduct a more rigorous analysis involving a direct comparison between groups, which showed no significant advantage for the training group. As in Cohen et al.'s study, both groups improved over time, but time was the only significant predictor, suggesting that practice effects are the most likely explanation.

In summary, the current study replicated Cohen et al.'s finding of an effect by less rigorous analysis but not by more rigorous analysis. As the more rigorous analysis was not completed with Cohen et al.'s data, it is possible that the training produced no true effects either study.

4.1.3. Did the training task affect the training and control groups differently, but not lead to differences in worry?

Although it is, as discussed above, possible that Cohen et al.'s (2015) demonstration of training effectiveness is unreliable, they certainly did find a group difference in rumination. It could therefore be that there were effects arising from their training that transferred to rumination, and that those same effects (too subtle to detect by the analyses of training performance) also occurred in this study but did not transfer to worry. A number of possible reasons for this are outlined.

4.1.3.1. Differences between rumination and worry

If rumination is more susceptible than worry to being influenced by changes resulting from training (whether these arise from improved attentional control or reduced processing of negative material), then transfer to worry may not occur. Although worry is strongly associated with deficits in attentional control, this training paradigm specifically targets inhibitory processes, and there is a greater body of research evidence linking rumination with inhibitory deficits than there is for worry (Beckwé, Deroost, Koster, De Lissnyder, & De Raedt, 2014). It is possible, then, that inhibitory training might transfer more effectively to rumination than to worry.

Moreover, there is some evidence to suggest that worry is associated with higher levels of verbal thought, and less imagery, than rumination (Goldwin & Behar, 2012; Kircanski, Thompson, Sorenson, Sherdell, & Gotlib, 2015; Papageorgiou & Wells, 2003). If this is the case, then the visual stimuli used in the training procedure may be less effective in producing an effect that transfers to worry.

4.1.3.2. Differences in the transfer tasks

Cohen et al.'s (2015) rumination task required participants to spend a period of time remembering an upsetting event, followed by a period of sitting quietly, and then to report state rumination on a 10-item visual analogue scale. It is thus largely a measure of the tendency to ruminate during that time. The current study required participants to worry for a period, then attempt to stop worrying. This may simply be a more generally demanding task, requiring greater effects during training to show transfer.

Alternatively, the worry transfer task may be a more rigorous test specifically of attentional control, rather than just a reduced tendency towards negative thinking, in that it required participants to make an active attempt to stop worrying following a period of thinking about personally threatening material. Deficits in inhibitory attentional control (as indicated by poor performance in a flanker task) have been shown to correlate with an inability to control negative intrusions in a worry task (Fox et al., 2015), suggesting that a task requiring inhibition of intrusions may be a good test of attentional control training. If the training task does not, in fact, improve attentional control, transfer to a task specifically requiring good attentional control might not be found.

4.1.3.3. Differences in procedure

Several procedural differences between the current study and Cohen et al.'s (2015) study may have led to different findings in the rumination/worry transfer tasks. Firstly, the nature of tasks between the training and the transfer task in the current study might have been reversed by repeated exposure to further threat materials. Direct comparison with Cohen et al.'s study is not possible here, as they simply report that participants completed "additional cognitive tasks" between training and rumination. It seems unlikely, though, that those tasks involved anything akin to the attentional control transfer task, which required participants to be further exposed to combinations of flankers, pictures and colour discrimination, or the recognition task, which involved examining pictures. Although booster training was included prior to the worry transfer task to try to mitigate this, it may, at only 24 trials, have been too short to work.

Alternatively, if the training task led to mood differences, the different intervening tasks in the two studies might have varied in the effects they had on mood. In the current study, a filler task was included between the booster training and the worry transfer task to try to eliminate the effects of mood. This was a methodological flaw, which may have affected result.

Finally, the nature and length of intervening tasks in the current study may mean that cognitive fatigue played a role. Some support for this idea comes from performance on the worry transfer task: just under half the participants failed to respond on the first trial. While there are no published data to compare this with, the

task is currently being piloted in other studies, and it appears that these findings are unusual. Fatigue may therefore have led to lapses in concentration on the task, rendering the data unreliable.

4.2. Possible mechanisms of change

The study attempted to test two competing theories for the mechanism of any change resulting from the training: increased attentional control improving the ability to inhibit negative material, or depleted attentional resources resulting in reduced processing of negative material resulting in reduced impact on mood. Table 8 and Table 9 summarise the predictions and key findings in support of each hypothesis. Conclusions drawn here must inevitably be very tentative, as overall the evidence suggests that the training was unlikely to have been effective. Additionally, more predictions were made for the depleted attentional resources theory, which may give the impression of greater support for this theory.

Table 8

Predictions and findings for the theory that training improving attentional control

Task Prediction	Met	Findings
Training task Training group will show an improvement over time during training on colour discrimination speeds following threat pictures (compared to control group)	No	Direct comparison between groups for first and last blocks shows no significant difference (Although training group show a significant improvement in second half of task, and control group do not, this is not a rigorous test of group differences)
Attentional control transfer task Training group will show less emotional interference	No	No significant group difference in emotional interference (i.e., no evidence that training group is less disrupted by negative pictures)

Table 9

Predictions and findings for the theory that training results in reduced processing of threat pictures

Task Prediction	Met	Findings
Training task Training group will show less impact of threat pictures on colour discrimination speeds than control group across all trials	No	No significant group differences
Mood ratings Control training group will have worse post-training mood	Partially	Greater reduction in positive mood for control group No significant difference in negative mood change
Worry task Post-training mood will predict performance	Partially	Positive mood is significant predictor of proportion of non-negative thoughts (but must be interpreted with caution as data may not have fully met requirements for linear regression) Mood not a significant predictor of longest run of non-negative thoughts
Recognition task Training group will perform less well at recognising threat pictures, control group less well at recognising neutral pictures	No	No significant group differences

Predictions relating to mood changes and their effects are particularly important for the theory of reduced processing of threat pictures, as this is presumed to account any group differences in negative thinking. Cohen et al. (2015) also noted this possibility, and examined mood change using a mood rating scale that the current one is modelled on. They do not report the pattern of any mood differences between groups, but report that they were not significant. They did, however, as part of a further analysis, report an interaction between a measure of habitual brooding and training condition on sad mood, suggesting the possibility of some more subtle mood differences between the groups. They also divided their scale into three subscales (sad, happy and anxious moods), in contrast to the current study, which only divided it into positive and negative moods; the greater variance that may arise from scales with fewer items could reduce the chance of group difference reaching significance.

Overall, the evidence in support of either theory is weak. The only evidence to support the theory that attentional control is being trained is a single finding of improvement in the training task that is based on poor statistical analysis, and contradicted by a more rigorous analysis. The partial findings of mood effects offer some support for theory of reduced processing of threat pictures. However, the recognition task findings do not provide the predicted support: the test appears to have been sensitive enough to find an expected effect of more accurate of negative pictures in general (Kensinger, 2011), so a failure to find a group difference is problematic for this theory.

4.3. Clinical implications

The largely negative, and best equivocal, nature of the findings limit the clinical significance of this research. If the training procedure could be improved such that it led to a reduction in worry, then in principle it could form the basis of a more clinically focused training paradigm. However, it would be important first to investigate more thoroughly the mechanisms through which the apparent worry reduction came about. If the reduced threat processing theory is correct, any transfer effects are simply the result of worse mood in the control group and no meaningful treatment could be developed based on this. If, on the other hand, it were to emerge that the training paradigm does increase the ability to exert attentional control to inhibit threatening material, this could have implications for clinical practice.

Attentional control deficits are thought to be central to worry and anxiety (Eysenck et al., 2007; Hirsch & Mathews, 2012), and improving attentional control may therefore bring about changes in some of the underlying cognitive processes contributing to the persistence of worry.

4.4. Limitations

The study has a number of limitations. Basing the choice of pictures in IAPS valence and arousal data, although it followed Cohen et al.'s (2015) procedure, seems likely to have been flawed, given that the perception of threat may be very different when pictures are viewed for 100 ms as opposed to the 6 s viewing used for the original ratings. The choice of items for measuring mood may not have been ideal; a mixture of negative mood items were chosen from the PANAS-X (see Appendix 7), but given the associations between threat, anxiety and worry, a measure of mood focused more specifically on anxiety might have been more sensitive to relevant change. The inclusion of a filler task after booster training was a notable methodological flaw, given that testing for an effect of hypothesised mood effects was an aim of the study.

More generally, the complexity of the design, while enabling multiple tests of the competing theories in the hope of strengthening the overall findings, may have worked against finding clear results in some individual tasks. Although the overall session length was not unreasonably long, the large number of tasks involving repeated presentations of stimuli requiring fast decision times may have led to significant cognitive fatigue. It is possible that some combination of the length of time between the training and worry transfer tasks, the shortness of the booster training, and the effects of fatigue, may have served to erase any potential group differences.

Although a power calculation was completed for the worry transfer task, and the sample size based on this, no such calculation was completed for the other analyses. While this is unlikely to explain any differences from Cohen et al.'s (2015) findings, as the sample sizes were very similar (68 in Cohen et al., 69 in the current study), it does raise the possibility that the current study was underpowered to detect a smaller effect.

4.5. Conclusions

The study did not provide evidence to suggest that repeated pairings of incongruent flanker decisions with threat stimuli can result in reduced worry. Nor did it provide significant support for the idea that doing so can improve attentional control, such that attention to threatening material can be more easily inhibited. It provided some very limited support for the idea that the effects found in a comparable study aimed at reducing rumination may have arisen from depleted attentional resources, resulting in reduced exposure to distressing stimuli, but this conclusion can be no more than very tentative at this point.

5. References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, D.C.: American Psychiatric Association.

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment*, *10*(2), 176–181. https://doi.org/10.1037/1040-3590.10.2.176

Baddeley, A. D., Emslie, H., & Nimmo-Smith, I. (1992). *The Speed and Capacity of Language Processing (SCOLP) Test*. Bury St Edmunds, England: Thames Valley Test Company.

Beckwé, M., Deroost, N., Koster, E. H. W., De Lissnyder, E., & De Raedt, R. (2014). Worrying and rumination are both associated with reduced cognitive control. *Psychological Research*, *78*(5), 651–660. https://doi.org/10.1007/s00426-013-0517-5

Borkovec, T. D., Robinson, E., Pruzinsky, T., & DePree, J. A. (1983). Preliminary exploration of worry: Some characteristics and processes. *Behaviour Research and Therapy*, *21*(1), 9–16. https://doi.org/10.1016/0005-7967(83)90121-3

Brown, T. A., Antony, M. M., & Barlow, D. H. (1992). Psychometric properties of the Penn State Worry Questionnaire in a clinical anxiety disorders sample. *Behaviour Research and Therapy*, *30*(1), 33–37. https://doi.org/10.1016/0005-7967(92)90093-V

Cepeda, N. J., Kramer, A. F., & Gonzalez de Sather, J. C. (2001). Changes in executive control across the life span: Examination of task-switching performance. *Developmental Psychology*, *37*(5), 715–730. https://doi.org/10.1037/0012-1649.37.5.715

Cohen, N., Henik, A., & Moyal, N. (2012). Executive control attenuates emotional effects—For high reappraisers only? *Emotion*, *12*(5), 970–979. https://doi.org/10.1037/a0026890

Cohen, N., Mor, N., & Henik, A. (2015). Linking executive control and emotional response: A training procedure to reduce rumination. *Clinical Psychological Science*, *3*(1), 15–25. https://doi.org/10.1177/2167702614530114

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy*, *1*(3), 192–205. https://doi.org/10.1521/ijct.2008.1.3.192

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics*, *16*(1), 143–149. https://doi.org/10.3758/BF03203267

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences*, *50*(7), 955–960. https://doi.org/10.1016/j.paid.2010.08.019

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion (Washington, D.C.)*, *7*(2), 336–353. https://doi.org/10.1037/1528-3542.7.2.336

Fox, E., Dutton, K., Yates, A., Georgiou, G. A., & Mouchlianitis, E. (2015). Attentional control and suppressing negative thought intrusions in pathological worry. *Clinical Psychological Science*, *3*(4), 593–606. https://doi.org/10.1177/2167702615575878

Fresco, D. M., Frankel, A. N., Mennin, D. S., Turk, C. L., & Heimberg, R. G. (2002). Distinct and overlapping features of rumination and worry: The relationship of cognitive production to negative affective states. *Cognitive Therapy and Research*, *26*(2), 179–188. https://doi.org/10.1023/A:1014517718949

Gelman, A., & Stern, H. (2006). The difference between 'significant' and 'not significant' is not itself statistically significant. *The American Statistician*, *60*(4), 328–331. https://doi.org/10.1198/000313006X152649

Goldwin, M., & Behar, E. (2012). Concreteness of idiographic periods of worry and depressive rumination. *Cognitive Therapy and Research*, *36*(6), 840–846. https://doi.org/10.1007/s10608-011-9428-1

Hayes, S., Hirsch, C., & Mathews, A. (2008). Restriction of working memory capacity during worry. *Journal of Abnormal Psychology*, *117*(3), 712–717. https://doi.org/10.1037/a0012908

Hirsch, C. R., Hayes, S., & Mathews, A. (2009). Looking on the bright side: Accessing benign meanings reduces worry. *Journal of Abnormal Psychology*, *118*(1), 44–54. https://doi.org/10.1037/a0013473

Hirsch, C. R., & Mathews, A. (2012). A cognitive model of pathological worry. *Behaviour Research and Therapy*, *50*(10), 636–646. https://doi.org/10.1016/j.brat.2012.06.007

Kensinger, E. A. (2011). Remembering emotional experiences: The contribution of valence and arousal. *Reviews in the Neurosciences*, *15*(4), 241–252. https://doi.org/10.1515/REVNEURO.2004.15.4.241

Kircanski, K., Thompson, R. J., Sorenson, J. E., Sherdell, L., & Gotlib, I. H. (2015). Rumination and worry in daily life: Examining the naturalistic validity of theoretical constructs. *Clinical Psychological Science*, 2167702614566603. https://doi.org/10.1177/2167702614566603

Kramer, A. F., Larish, J. F., & Strayer, D. L. (1995). Training for attentional control in dual task settings: A comparison of young and old adults. *Journal of Experimental Psychology: Applied*, *1*(1), 50–76. https://doi.org/10.1037/1076-898X.1.1.50

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual* (Technical Report No. A-8). Gainesville, FL: University of Florida.

Llera, S. J., & Newman, M. G. (2010). Effects of worry on physiological and subjective reactivity to emotional stimuli in generalized anxiety disorder and nonanxious control participants. *Emotion*, *10*(5), 640–650. https://doi.org/10.1037/a0019351

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales* (2nd ed.). Sydney, Australia: Psychology Foundation.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behaviour Research and Therapy*, *28*(6), 487–495. https://doi.org/10.1016/0005-7967(90)90135-6

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Molina, S., & Borkovec, T. D. (1994). The Penn State Worry Questionnaire: Psychometric properties and associated characteristics. In G. C. L. Davey & F. Tallis (Eds.), *Worrying: Perspectives on theory, assessment and treatment* (pp. 265–283). Oxford, England: Wiley.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*(5), 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

Papageorgiou, C., & Wells, A. (2003). Nature, functions, and beliefs about depressive rumination. In C. Papageorgiou & A. Wells (Eds.), *Depressive rumination* (pp. 1–20). John Wiley & Sons Ltd. https://doi.org/10.1002/9780470713853.ch1

Ruscio, A. M., Lane, M., Roy-Byrne, P., Stang, P. E., Stein, D. J., Wittchen, H.-U., & Kessler, R. C. (2005). Should excessive worry be required for a diagnosis of generalized anxiety disorder? Results from the US national comorbidity survey replication. *Psychological Medicine*, *35*(12), 1761–1772. https://doi.org/10.1017/S0033291705005908

Siegle, G. J., Price, R. B., Jones, N. P., Ghinassi, F., Painter, T., & Thase, M. E. (2014). You gotta work at it: Pupillary indices of task focus are prognostic for response to a neurocognitive intervention for rumination in depression. *Clinical Psychological Science*, *2*(4), 455–471. https://doi.org/10.1177/2167702614536160

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior Research Methods, Instruments, & Computers*, *31*(1), 137–149. https://doi.org/10.3758/BF03207704

Stefanopoulou, E., Hirsch, C. R., Hayes, S., Adlam, A., & Coker, S. (2014). Are attentional control resources reduced by worry in generalized anxiety disorder? *Journal of Abnormal Psychology*, *123*(2), 330–335. https://doi.org/10.1037/a0036343

Szabó, M. (2011). The emotional experience associated with worrying: Anxiety, depression, or stress? *Anxiety Stress and Coping*, *24*(1), 91–105. https://doi.org/10.1080/10615801003653430

Tabachnick, B. G., & Fidell, L. S. (2005). *Using multivariate statistics* (5 edition). Boston, MA: Pearson.

Watson, D., & Clark, L. A. (1999). *The PANAS-X: Manual for the Positive and Negative Affect Schedule - Expanded Form*. Ames, IA: University of Iowa.

Whelan, R. (2010). Effective analysis of reaction time data. *The Psychological Record*, *58*(3).

Appendix 1: Ethical approval

Research Ethics
Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
rec@kcl.ac.uk

KING'S College LONDON

Lucy Mackintosh

9 March 2016

Dear Lucy,

Study Title: Does recruiting attentional control in the presence of threat reduce worry? (Short title: Worry and attentional control)

Study Reference: HR-15/16-2312

I am pleased to inform you that full approval for your project has been granted by the PNM Research Ethics Subcommittee

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information, ethical approval is granted until 9th March 2019. If you need approval beyond this point, you will need to apply for an extension at least two weeks before this. You will be required to explain the reasons for the extension. However, you will not need to submit a full re-application unless the protocol has changed. If you have been granted approval for only 12 months, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the data-collection phase of the study. This will be until the date specified in this letter. However, you do not need ethical approval to cover subsequent data analysis or publication of the results.

For secondary data-analysis, ethical approval is applicable to the data that is sensitive or identifies participants.

Approval is applicable to period in which such data is accessed or evaluated.

Please note you are required to adhere to all research data/records management and storage procedures agreed to as part of your application. This will be expected even after the completion of the study.

If you do not start the project within three months of this letter, please contact the Research Ethics Office.

Please note that you will be required to obtain approval to modify the study. This also encompasses extensions to periods of approval. Please refer to the URL below for further guidance about the process:

http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact the Research Ethics Office:

(http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx)

We wish you every success with this work.

Yours sincerely,

James Patterson - Senior Research Ethics Officer

For and on behalf of

Chair of the PNM Research Ethics Subcommittee

Cc: Colette Hirsch

Research Ethics
Office

Franklin Wilkins Building
5.9 Waterloo Bridge Wing
Waterloo Road
London SE1 9NH
Telephone 020 7848 4020/4070/4077
rec@kcl.ac.uk

KING'S College LONDON

7 October 2016

Dear Lucy

Reference Number: RESCMR-16/17-2312

Study Title: Does recruiting attentional control in the presence of threat reduce worry? (Short title: Worry and attentional control)

Modification Review Outcome: Approval with provisos

Thank you for submitting a modification request for the above study. I am writing to confirm that your request has been approved with provisos specified below:

1. It is recommended that if you should recruit those with generalised anxiety disorder, they are monitored carefully. You should also have a suitable protocol for dealing with distress should it occur.

You are not required to provide evidence that these provisos have been met. However, the approval of your modification is only valid if these changes are made. You must not implement this modification until these provisos have been met.

If you have any questions regarding this application please contact the Research Ethics Office.

Kind regards

Research Ethics Office

On behalf of

PNM Research Ethics Subcommittee

Appendix 2: Study information sheet

Version 4. 30/09/16

ONLINE INFORMATION SHEET FOR PARTICIPANTS

REC Reference Number: HR-15/16-2312

KING'S College LONDON

Information, attention and worry

You are being invited to take part in a research study. It is up to you whether you take part. To help you decide, please read this information sheet so you can learn more about what it involves.

What is the purpose of the study?

The study will help us learn more about how worry is linked to people's ability to focus their attention. We know that people who worry a lot can find it hard to ignore things that might worry them, and to switch their attention from one thing to another. We are trying to find out more about this by seeing how people who worry perform different tasks. In the long term, this may help with developing more effective help for people with anxiety disorders who experience severe, uncontrollable worry.

Why have I been invited to take part?

You have responded to a request for participants for this study. You need to be aged 18+, a native or fluent English speaker, with normal vision (wearing glasses if you need them) and normal colour vision.

Do I have to take part?

No – it is completely up to you. If you do decide to take part, you can change your mind at any point during the study, and your data will be removed. You can also ask us to remove your data after you have taken part, at any time until 31 March 2017.

What will happen if I take part?

You will fill in a questionnaire on this website. If you are eligible for the study on the basis of this, you will be invited to come to King's College London (Denmark Hill Campus or Guys Campus) for a single session, lasting about 1 ½ hours. Before the session, you will fill in some more questionnaires about your mood and thinking. During the session, you will do several tasks on the computer. These will involve looking at pictures, and making simple decisions including which direction arrows are pointing in and what colour things are. You will do some tasks on paper, in which you will make other decisions about words and sentences. You will also be asked to spend some time worrying about something, and try to stop worrying (you get to decide what to topic to worry about). At the end, the researcher will explain a bit more about the study, and answer any questions. We can give you £15 to cover your time and travel.

Are there any risks to taking part?

You may feel anxious or a bit low when filling in questionnaires about your worry and mood, although most people find this passes quickly. You will see pictures that are related to threat and worry, and some people may find these upsetting. You will be asked to spend some time worrying during the session, and to talk about this, although you can choose the topic. We don't expect

most people to find this very stressful, but the researcher will be able to discuss this at the end, and to suggest places to get further support if you want. You can decide to stop at any time during the session, and ask us not to use your data.

Are there any benefits to taking part?

There are no specific benefits for you, but we hope that the research will contribute to developing better help for people who experience anxiety.

Will my information be kept confidential?

Yes. Your responses and data will only be identified by a participant number. We will need to keep your contact details so we can invite you to the session, and so we can identify your data if you want to withdraw, but this will be kept separately and destroyed at the end of the study. Consent forms with your name and receipts for payment will be kept separately and cannot be linked to your data. The anonymised study data will be kept for 7 years at King's College London. All data will be kept in locked storage or on password-protected computer systems, and will only be seen by members of the research team. If you tell us anything that might suggest a risk to you or others (e.g., thoughts of harming yourself or others; criminal activity), we may have to break confidentiality and inform a third party.

What will happen to the results of the study?

This study is being conducted for a doctoral programme at King's College London. The results will form part of a thesis submitted to King's College London, and published in a journal and presented at conferences. Publication will not include any identifying details about you.

Who should I contact for further information?

If you have any questions or require more information about this study, please contact Lucy Mackintosh, Trainee Clinical Psychologist, Department of Psychology, PO 78, Institute of Psychiatry, Psychology & Neuroscience, 4 Windsor Walk, London, SE5 8AF, or via email lucy.mackintosh@kcl.ac.uk or kcl-cognition@kcl.ac.uk

What if I have further questions, or if something goes wrong?

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact King's College London using the details below for further advice and information: Dr Colette Hirsch, Department of Psychology, Institute of Psychiatry, Psychology and Neuroscience, De Crespigny Park, London SE5 8AF, or via email colette.hirsch@kcl.ac.uk, or via phone 020 78480697

Thank you for reading this information sheet and for considering taking part in this research.

Appendix 3: Consent form

ID: _____ Version 4. 30/09/16

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: **Information, attention and worry**

King's College Research Ethics Committee Ref: HR-15/16-2312

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.	☐
1. I confirm that I have read and understood the information sheet dated 01/09/16 for the above study. I have had the opportunity to consider the information and had the opportunity to ask questions, which have been answered satisfactorily.	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. Furthermore, I understand that I will be able to withdraw my data up 31.03.17	☐
3. I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.	☐
4. I understand that my information may be subject to review by responsible individuals from the College for monitoring and audit purposes.	☐
5. I understand that confidentiality and anonymity will be maintained and it will not be possible to identify me in any publications	☐
6. I agree to be contacted in the future by King's College London researchers who would like to invite me to participate in follow up studies to this project, or in future studies of a similar nature.	☐
7. I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee. (In such cases, as with this project, data would/would not be identifiable in any report).	☐
8. I consent to completing questionnaires and seeing pictures that may cause some anxiety.	☐
9. I consent to discussing and worrying about a topic of my choice. I understand that I can stop this task at any time.	☐

_____	_____	_____
Name of Participant	**Date**	**Signature**
_____	_____	_____
Name of Researcher	**Date**	**Signature**

Appendix 4: Picture stimuli

Threat pictures

Categories and examples of threat pictures:

- Individual threat and violence (e.g., pointed gun, assault)
- Group threat and violence (e.g., riot, armed soldiers)
- Accident and injury (e.g., car crash, fire)
- Medical (e.g., injection, surgery)
- Animals (snake with open jaws)
- Facial expressions (e.g., angry, distressed)

Neutral pictures

Categories and examples of neutral pictures:

- Activities (e.g., card game, shopping)
- Scenes (e.g., street scene, shipyard)
- Objects (e.g., fruit, basket),
- Natural environment (e.g., field, sky)
- Neutral facial expressions

Picture set comparisons

Five sets of pictures were used in total, each consisting of half threat and half neutral pictures: 24 used only in the attentional control transfer tasks, 24 used only in the training task, 24 used both in the attentional control transfer tasks and in the training task, 24 distractor items used in the recognition task, and 24 used for a booster training task. One-way ANOVAs for the five sets of threat pictures showed no significant effect of set on valence, $F(4,55) = 0.26$, $p = .09$, or on arousal, $F(4,55) = 0.04$, $p = .99$. One-way ANOVAs for the five sets of neutral pictures showed no significant effect of set on valence, $F(4,55) = 0.86$, $p = .50$, or on arousal, $F(4,55) = 0.27$, $p = .90$.

Appendix 5: Penn State Worry Questionnaire (PSWQ)

Patient Name:_____ Date:_____

The Penn State Worry Questionnaire (PSWQ)

Instructions: Rate each of the following statements on a scale of 1 ("not at all typical of me") to 5 ("very typical of me"). Please do not leave any items blank.

	Not at all typical of me				Very typical of me
1. If I do not have enough time to do everything, I do not worry about it.	1	2	3	4	5
2. My worries overwhelm me.	1	2	3	4	5
3. I do not tend to worry about things.	1	2	3	4	5
4. Many situations make me worry.	1	2	3	4	5
5. I know I should not worry about things, but I just cannot help it.	1	2	3	4	5
6. When I am under pressure I worry a lot.	1	2	3	4	5
7. I am always worrying about something.	1	2	3	4	5
8. I find it easy to dismiss worrisome thoughts.	1	2	3	4	5
9. As soon as I finish one task, I start to worry about everything else I have to do.	1	2	3	4	5
10. I never worry about anything.	1	2	3	4	5
11. When there is nothing more I can do about a concern, I do not worry about it any more.	1	2	3	4	5
12. I have been a worrier all my life.	1	2	3	4	5
13. I notice that I have been worrying about things.	1	2	3	4	5
14. Once I start worrying, I cannot stop.	1	2	3	4	5
15. I worry all the time.	1	2	3	4	5
16. I worry about projects until they are all done.	1	2	3	4	5

Appendix 6: Depression, Anxiety and Stress Scale short form (DASS21)

DASS21	*Name:*	*Date:*			
Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.					
The rating scale is as follows: 0 Did not apply to me at all 1 Applied to me to some degree, or some of the time 2 Applied to me to a considerable degree, or a good part of time 3 Applied to me very much, or most of the time					
1	I found it hard to wind down	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I found it difficult to work up the initiative to do things	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I experienced trembling (eg, in the hands)	0	1	2	3
8	I felt that I was using a lot of nervous energy	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting agitated	0	1	2	3
12	I found it difficult to relax	0	1	2	3
13	I felt down-hearted and blue	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15	I felt I was close to panic	0	1	2	3
16	I was unable to become enthusiastic about anything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life was meaningless	0	1	2	3

Appendix 7: Mood assessment

All items taken from the Positive and Negative Affect Schedule – Expanded Form ([PANAS-X], Watson & Clark, 1999).

Positive mood items

- At ease
- Cheerful
- Relaxed
- Happy
- Calm
- Enthusiastic

Negative mood items

- Frightened
- Distressed
- Downhearted
- Shaky
- Sad
- Upset
- Nervous

Appendix 8: Filler task

Adapted from the Speed of Comprehension Test (Baddeley et al., 1992)

Removed for copyright reasons

Removed for copyright reasons

Appendix 9: Data exclusions

Training task

One control group participant completed only 10% of colour discrimination responses accurately, so their data were excluded from the analysis. 10.8% of all remaining trials were excluded as follows (note that some trials may be excluded for more than one reason): missed flanker response (3.1%), missed colour discrimination response (0.8%), inaccurate flanker response (2.1%), inaccurate colour discrimination response (4.9%), flanker RTs below 150 ms (0.01%), colour discrimination RTS below 150 ms (0.02%), and colour discrimination RTs above 1,500 ms (0.6%).

Mood

Data from two control group participants were excluded, one due to a technical error in data collection, and one because their scores represented an extreme outlier for both positive and negative difference scores (greater than quartile ± 3 x interquartile range of the sample as a whole).

Worry transfer task

One control group participant was an extreme outlier in terms of missing trials, with 36.7% of trials missing, but as preliminary analyses indicated that dropping their data had no marked effects on the findings, their data were retained. Another neutral training participant missed two trials because of equipment failure, but their total completed trials were well within the ordinary range for participants as a whole, and so their data were also retained.

Attentional control task

Trials were not excluded in the basis of colour discrimination scores, as these were not used in the subsequent analyses. For the baseline task data, one control group participant completed only 27% of flanker discrimination responses accurately, so their data were excluded from baseline analyses (not reported here); 3.9% of all remaining trials were excluded because of missed flanker responses, and 0.03% for

flanker RTs < 150 ms. For the post-training task data, 2.2% of trials were excluded because of missed flanker responses and 0.03% for flanker RTs < 150 ms.

Recognition task

Forty-seven individual trials with RTs below 150 ms were dropped; this represented 1.42% of all trials. One threat training condition participant's mean confidence data was an extreme outlier: 10.25 for neutral pictures and 6.46 for threat pictures, compared with a range for the remaining participants of 46.92–96.29 and 41.67–92.91 for neutral and threat pictures respectively. Preliminary analyses suggested that removing this participant's data did not affect overall significance levels, and did lead to improvements in the distribution of residuals, which were highly non-normally distributed. Furthermore, the confidence ratings are an entirely subjective measure, which means individual differences not relevant to the main hypotheses may have contributed to these unusual scores. Their data were therefore removed.

Appendix 10: Training task analysis: Recruitment of attentional control

To check that attentional control was being recruited by the incongruent flankers (and thus that this aspect of the task was working correctly), an analysis was carried out of flanker response speeds. This follows Cohen et al.'s analysis of training task data.

A multilevel linear modelling analysis was carried out with flanker responses speed as the dependent variable. Training condition (threat training, neutral training), congruence (congruent, incongruent), and the interaction between them were entered as predictors. It was predicted that the typical congruence effect would be found, and that any effect of group or interaction would suggest that the attentional control was being recruited differentially between groups (which was not anticipated, but would indicate a need to control for this in further analyses).The results yielded the predicted main effect of congruence (b = -0.27, SE = 0.02, $p < .001$), with response speeds on congruent trials being faster (M = 2.23, SD = 0.27) than incongruent (M = 1.96, SD = 0.27), d = 0.96. There was no significant main effect of training condition (b = -0.01, SE = 0.06, p = .88) and no significant interaction between training condition and congruence (b = 0.02, SE = 0.03, p = .44), suggesting that the flanker task worked as intended, and attentional control was recruited similarly in both groups.

Note: Examination of the standardised residuals suggested the possibility of a non-linear relationship; however, data transformation did not affect the outcomes of the analysis, and so the untransformed data were retained.

Appendix 11: Training task analysis – effect of picture valence scores

The main analysis (reported in the Results section) showed no effect of pictures valence on colour discrimination speeds in the training task (although the direction of difference, with discrimination decisions following neutral pictures being slightly faster (M = 2.09, SD = 0.45) than those following threat pictures (M = 2.06, SD = 0.45), d = 0.08, was as expected). A further analysis was carried out to explore this unexpected result.

Simple linear regression analyses were carried out, using the IAPS valence scores of the picture stimuli as a continuous predictor variable. Valence score significantly predicted colour discrimination speeds, $F(1, 46) = 6.01$, $p = .02$, $R^2 = .12$. However, this relationship was no longer found when threat and neutral pictures were considered separately: valence of threat pictures was not a significant predictor for threat, $F(1, 24) = 0.87$, $p = .36$, $R^2 = .04$; neither was valence of neutral pictures, $F(1, 24) = 0.09$, $p = .76$, $R^2 = .00$. As Figures , 4 and 5 make clear, the small valence effect, accounting for 12% of the variability in colour discrimination scores overall, appears to arise from the existence of the two categories of picture (threat and neutral); within the categories, there is no significant relationship between valence and speed.

This suggests that, while negative pictures tend to have a greater impact on subsequent colour discrimination speeds than neutral pictures do, the effect is likely to be small, and the relationships is weak at the level of individual picture valences. This may have affected the effectiveness of the training, which paired incongruent flankers with negative pictures. It may also have meant that difference in colour discrimination speeds following threat pictures in training is a poor measure of training effectiveness.

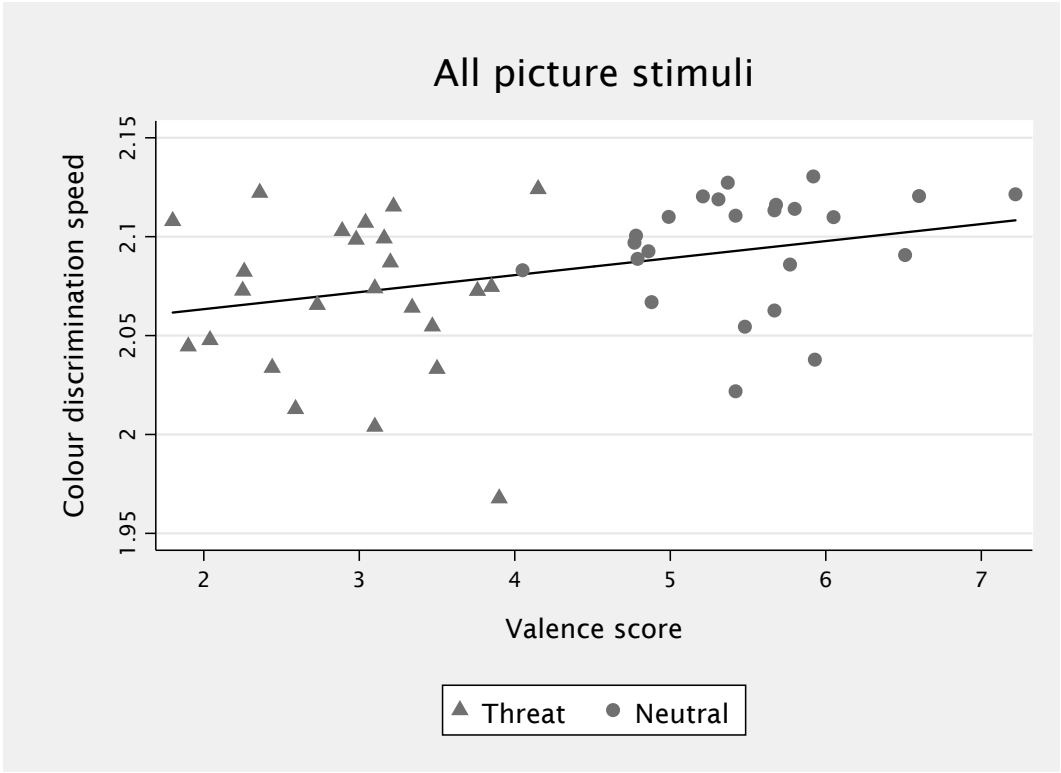


Figure 3. Valence score of all pictures as a predictor of colour discrimination speeds, showing a significant effect

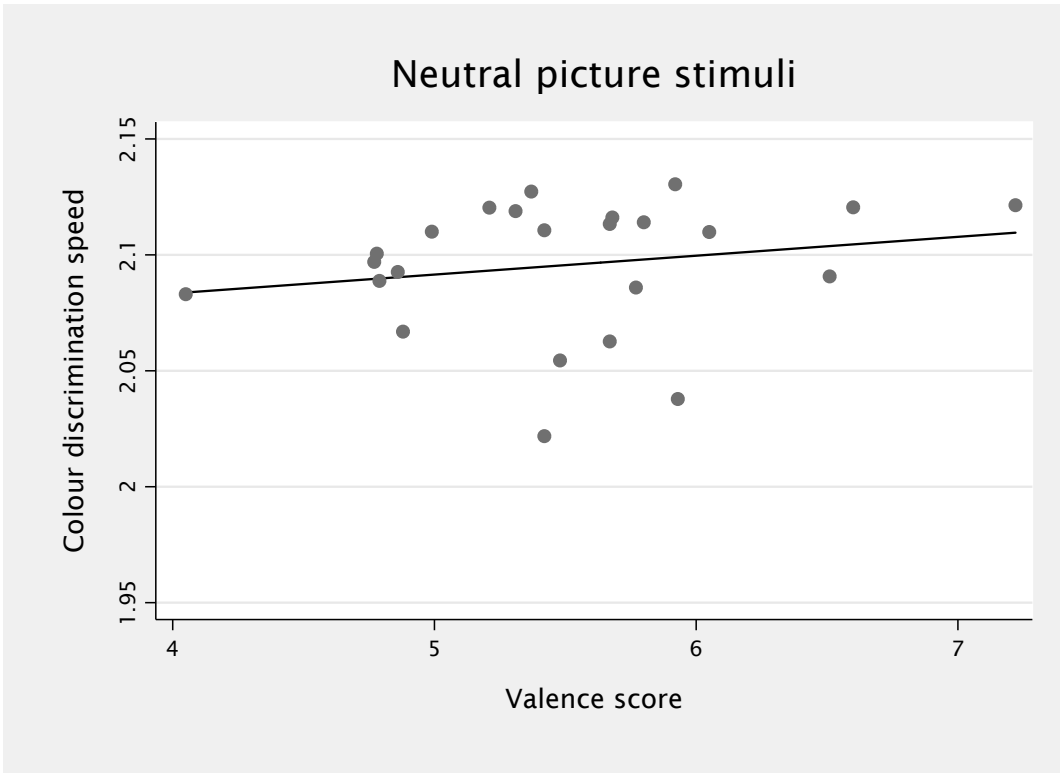


Figure 4. Valence score of neutral pictures as a predictor of colour discrimination speeds, showing no significant effect

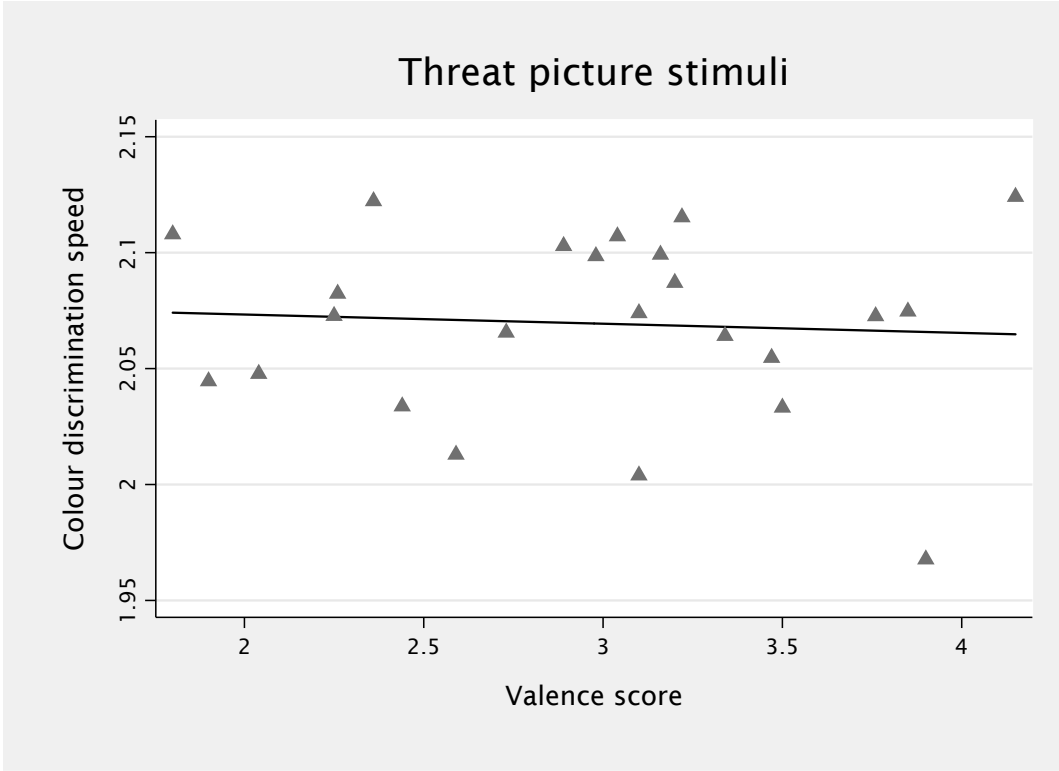


Figure 5. Valence score of threat pictures as a predictor of colour discrimination speeds, showing no significant effect